Bonus Satellite TV Catalog From Av-Comm

SILICON CHIP

$4.50 JANUARY 1994
NZ $5.95 INCL GST

AUSTRALIA'S DYNAMIC ELECTRONICS MAGAZINE

ERVICING – VINTAGE RADIO – COMPUTERS – AMATEUR RADIO – PROJECTS TO BUILD

5 PROJECTS TO BUILD

3A 40V ADJUSTABLE POWER SUPPLY

SOLAR BATTERY REGULATOR

STEPPER MOTOR CONTROLLER

MINI DRILL SPEED CONTROLLER

PRINTER STATUS INDICATOR

$6000 WORTH OF TEKTRONIX TEST GEAR TO BE WON

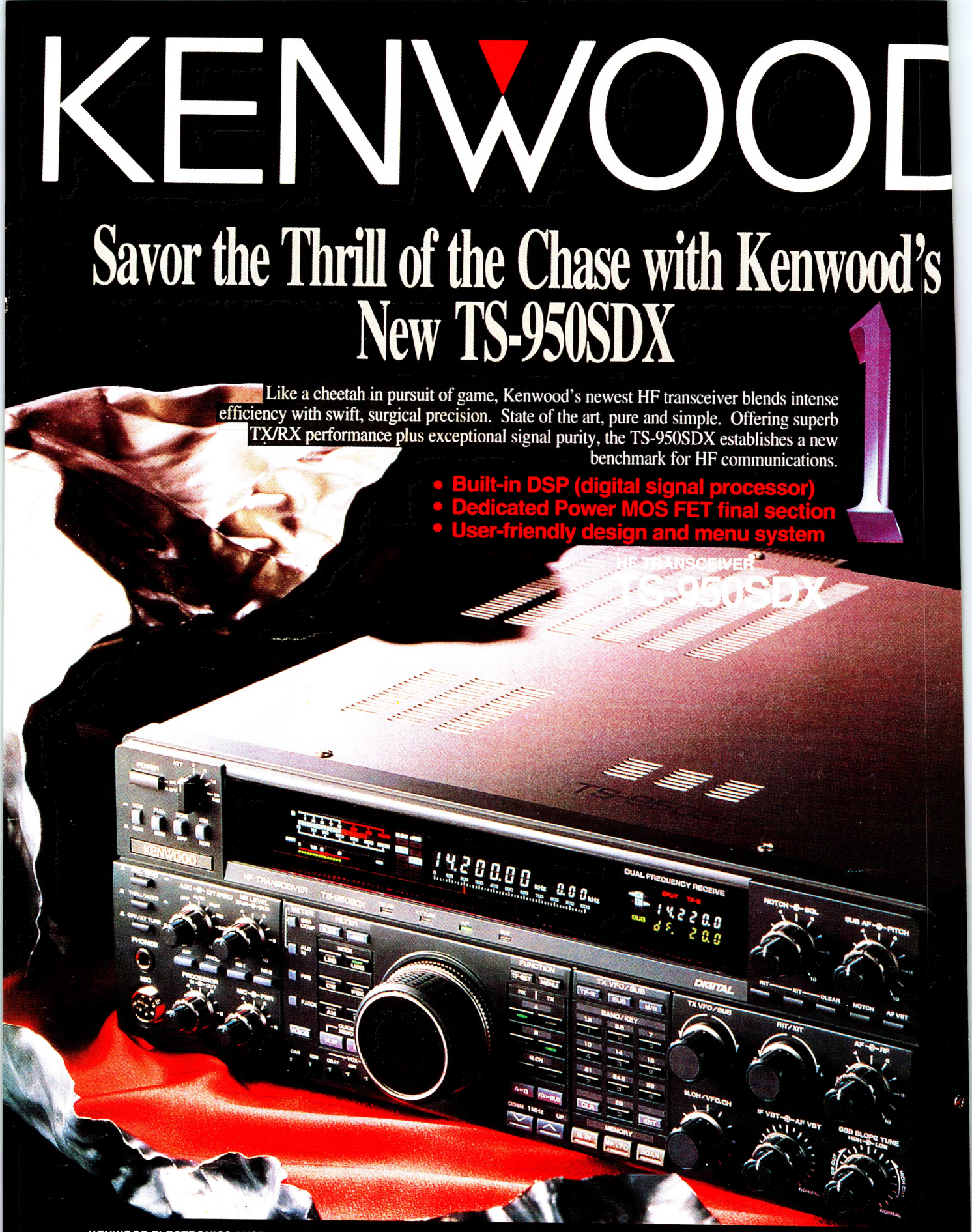
TO PRINTER

KENWOOD

Savor the Thrill of the Chase with Kenwood's New TS-950SDX

Like a cheetah in pursuit of game, Kenwood's newest HF transceiver blends intense efficiency with swift, surgical precision. State of the art, pure and simple. Offering superb TX/RX performance plus exceptional signal purity, the TS-950SDX establishes a new benchmark for HF communications.

- **Built-in DSP (digital signal processor)**
- **Dedicated Power MOS FET final section**
- **User-friendly design and menu system**



KENWOOD ELECTRONICS AUSTRALIA PTY LTD (ACN 001 499 074), PO Box 504, 8 Figtree Drive, Australian Centre, Homebush, NSW 2140, Australia. Tel (02) 746 1519 Fax: (02) 746 1509. **NSW** Emona Electronics Sydney (02) 211 0988. Lake Macquarie Communications Cardiff (049) 567 255. **ACT** Watts Communications Fyshwick (06) 280 6416. **QLD** Kenwood Communications Albion (07) 357 6830. **VIC** Strictly Ham Bayswater (03) 729 7656. Stewart Electronics Components Huntingdale (03) 543 3733. **SA** International Comms Systems Port Adelaide (08) 473 688. **WA** Leda Electronics St James (09) 361 7821. Tower Communications Victoria Park (09) 470 1118. **TAS** Elgin Pty Ltd Launceston (003) 312 711. Elgin Pty Ltd Hobart (002) 344 5000.

FOR AMATEUR RADIO USE ONLY

SILICON CHIP

Vol.7, No.1; January 1994

FEATURES

4 The World Solar Challenge *by Brian Woodward*
Honda wins at a record pace

7 What's New In Car Electronics? *by Julian Edgar*
Mazda's Collision Avoidance System

8 Electronic Engine Management, Pt.4 *by Julian Edgar*
Changing the system

30 Luxman A-371 Amplifier & D-351 CD Player *by Leo Simpson*
High quality equipment with no gimmicks

37 Active Filter Design For Beginners *by Elmo Jansz*
A quick primer to get you started

88 Review: Kenwood's DCS-9120 Oscilloscope *by John Clarke*
Features both digital & analog modes of operation

PROJECTS TO BUILD

16 Build A 40V 3A Variable Power Supply *by John Clarke*
Full overload protection, an LCD panel meter & a switching regulator

40 A Switching Regulator For Solar Panels *by Otto Priboj*
Can be used to charge 12V or 24V battery banks

44 Printer Status Indicator For PCs *by Darren Yates*
An alphanumeric display indicates printing problems

50 Simple Low-Voltage Speed Controller *by Darren Yates*
Will control 12V DC motors or lights

80 Control Stepper Motors With Your PC *by Marque Crozman*
You build an interface circuit & buy the software

SPECIAL COLUMNS

52 Vintage Radio *by John Hill*
Realism Realized – the Precedent console receiver

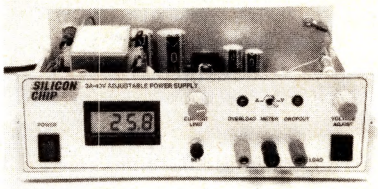
56 Serviceman's Log *by the TV Serviceman*
It was all a long time ago

65 Computer Bits *by Darren Yates*
Even more experiments for your games card

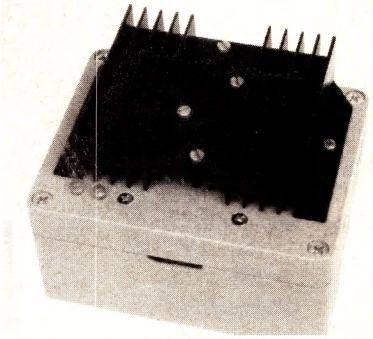
70 Remote Control *by Bob Young*
More on servicing your R/C transmitter

DEPARTMENTS

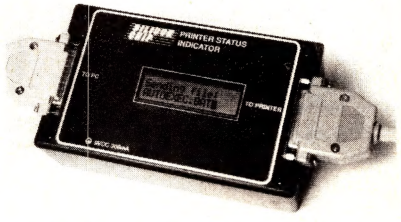
2 Publisher's Letter
24 Circuit Notebook
29 Order Form
68 Back Issues
90 Product Showcase
93 Ask Silicon Chip
95 Market Centre
96 Advertising Index



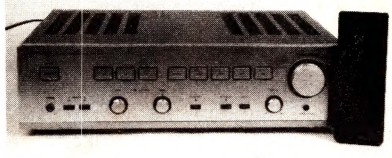
THIS 1.23-40V 3A VARIABLE power supply features a high-efficiency switching regulator, preset current limiting, full overload protection & an LCD panel meter. Construction starts on page 16.



IF YOU USE SOLAR PANELS, you need an efficient regulator to ensure that any associated batteries are correctly charged. This unit can be built in two versions (10A or 20A) and can charge a 12V or 24V battery band – see page 40.



ARE YOU OFTEN frustrated by files which disappear down your printer cable but don't print out? This printer status indicator uses an alphanumeric display panel to indicate problems as they occur. Details page 44.



THE LUXMAN company in Japan has a reputation for high quality audio equipment with no unnecessary frills or gimmicks. This month, we review their A-371 stereo amplifier & D-351 CD player. Turn to page 30.

Publisher & Editor-in-Chief
Leo Simpson, B.Bus.

Editor
Greg Swain, B.Sc.(Hons.)

Technical Staff
John Clarke, B.E.(Elec.)
Robert Flynn
Darren Yates, B.Sc.

Reader Services
Ann Jenkinson
Sharon Macdonald

Marketing Manager
Sharon Lightner
Phone (02) 979 5644
Mobile phone (018) 28 5532

Regular Contributors
Brendan Akhurst
Garry Cratt, VK2YBX
Marque Crozman, VK2ZLZ
John Hill
Jim Lawler, MTETIA
Bryan Maher, M.E., B.Sc.
Philip Watson, MIREE, VK2ZPW
Jim Yalden, VK2YGY
Bob Young

Photography
Stuart Bryce

SILICON CHIP is published 12 times a year by Silicon Chip Publications Pty Ltd. A.C.N. 003 205 490. All material copyright ©. No part of this publication may be reproduced without the written consent of the publisher.

Printing: Macquarie Print, Dubbo, NSW.

Distribution: Network Distribution Company.

Subscription rates: $49 per year in Australia. For overseas rates, see the subscription page in this issue.

Editorial & advertising offices: Unit 1a/77-79 Bassett Street, Mona Vale, NSW 2103. Postal address: PO Box 139, Collaroy Beach, NSW 2097. Phone (02) 979 5644. Fax (02) 979 6503.

ISSN 1030-2662

PUBLISHER'S LETTER

Some Australian companies still do not give good service

Talk to almost anyone these days who has recently purchased some product or service and you're bound to hear a sorry story about botched deliveries, return calls to fix installations, repeat calls for warranty service and, in general, a high level of frustration.

Two examples from our own staff serve as illustrations. Staff member No.1 arranged for a new garage door with UHF remote control to be installed. Within a few days, the door arrived and the installation team attempted to install it. They found that the door had been damaged and subsequently left after having also damaged the original door. One month and many phone calls later, a replacement door was finally installed but the remote control did not work properly – it had obviously never been tested. This required more phone calls and another visit from the installation team to put right.

Staff member No.2 purchased a new double wall oven with microprocessor control and all the latest whiz-bang features. It was installed but subsequently it was found that one element in one of the ovens did not work. It took four visits by different service personnel to solve a wiring error that was compounded by errors on the badly drawn circuit diagram.

I am sure that there are many thousands of such occurrences every year in Australia. Clearly, all these unnecessary repeat calls cost heaps of money to the companies concerned and it does nothing to build customer confidence in their ability to give good service. Apart from that, every time someone has to arrange to be at home for installation or service personnel to call means either a loss of income, or at the very least, quite a lot of inconvenience.

And then when we come to getting warranty service on products, the whole story repeats itself. You often have to take the product concerned to some out-of-the-way suburb where the people concerned are obviously poorly motivated and are probably thinking "not another one of these (censored) units!". So the poor customer has to make at least two visits to the service company and there is no guarantee that the unit will be fixed when it is returned.

None of this has to be. Electronic products these days are very reliable and once they are properly installed they should give many years of trouble-free service. But many companies clearly do not bother to check that the products they supply are properly assembled and that all functions work properly. Nor do they ensure that their products are correctly installed and that when they do ultimately need servicing, that servicing staff have the correct manuals and that they are polite and courteous to the customer. That's all fairly straightforward isn't it? It's about time these companies got their act together!

Leo Simpson

WARNING!

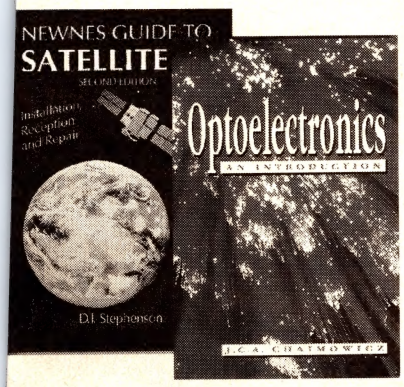
SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely. Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

Advertisers are warned that they are responsible for the content of all advertisements and that they must conform to the Trade Practices Act 1974 or as subsequently amended and to any governmental regulations which are applicable.

Silicon Chip Book Shop

Dedicated To Bringing You Books On State Of The Art Technology

These books are written by acknowledged specialists in their fields and will fill a longfelt requirement for reference texts. Each book is up to date, well written and most importantly, available now.



Satellite TV

Newnes Guide to Satellite TV; Installation, Reception & Repair. By Derek J. Stephenson. 2nd edition, published 1991, reprinted 1992.

This is a practical guide on the installation and servicing of satellite television equipment. The coverage of the subject is extensive, without excessive theory or mathematics. 284 pages, in hard covers at $45.95.

Optoelectronics

Optoelectronics: An Introduction, by J. C. A. Chaimowicz. First published 1989, reprinted 1992.

This field is about to explode and it is most important for engineers and technicians to bring themselves up to date. The subject is comprehensively covered, starting with optics and then moving into all aspects of fibre optic communications. 361 pages, in paperback at $55.95.

Linear Electronic Design

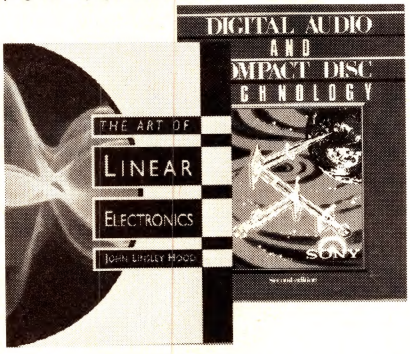
The Art of Linear Electronics, by John Linsley Hood. Published 1993.

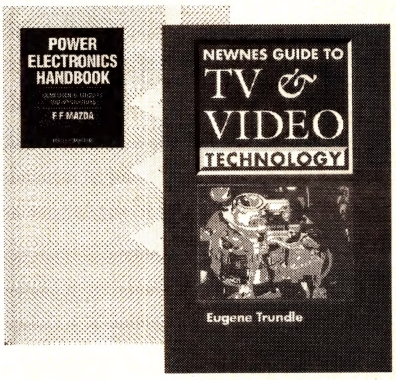
This is a practical handbook from one of the world's most prolific audio designers, with many of his designs having been published in English technical magazines over the years. A great many practical circuits are featured - a must for anyone interested in audio design. 336 pages, in paperback at $45.95.

Digital Audio

Digital Audio and Compact Disc Technology. Produced by the Sony Service Centre (Europe). 2nd edition, published 1992.

Prepared by Sony's technical staff, this is the best book on compact disc technology that we have ever come across. It covers digital audio in depth, including PCM adapters, the Video8 PCM format and R-DAT. If you want to understand digital audio, you need this reference book. 247 pages, in paperback at $59.95.





Power Electronics

Power Electronics Handbook, Components, Circuits & Applications, by F. F. Mazda. Published 1990.

Previously a neglected field, power electronics has come into its own, particularly in the areas of traction and electric vehicles. F. F. Mazda is an acknowledged authority on the subject and he writes mainly on the many uses of thyristors and Triacs in single and three phase circuits. 417 pages, in hard cover form at $59.95.

TV & Video

Newnes Guide to TV & Video Technology, by Eugene Trundle. First published 1988, reprinted 1990, 1992.

Eugene Trundle has written for many years in *Television* magazine and his latest book is right up date on TV and video technology. 432 pages, in paperback, at $39.95.

To order any of these books, fill out the coupon below & send it with your remittance to SILICON CHIP

Your Name_____
PLEASE PRINT

Address_____

_____ Postcode_____

Daytime Phone No._____ **Total Price $A** _____

❑ Cheque/Money Order ❑ Bankcard ❑ Visa Card ❑ Master Card

Card No. | | | | | | | | | | | | | | | | |

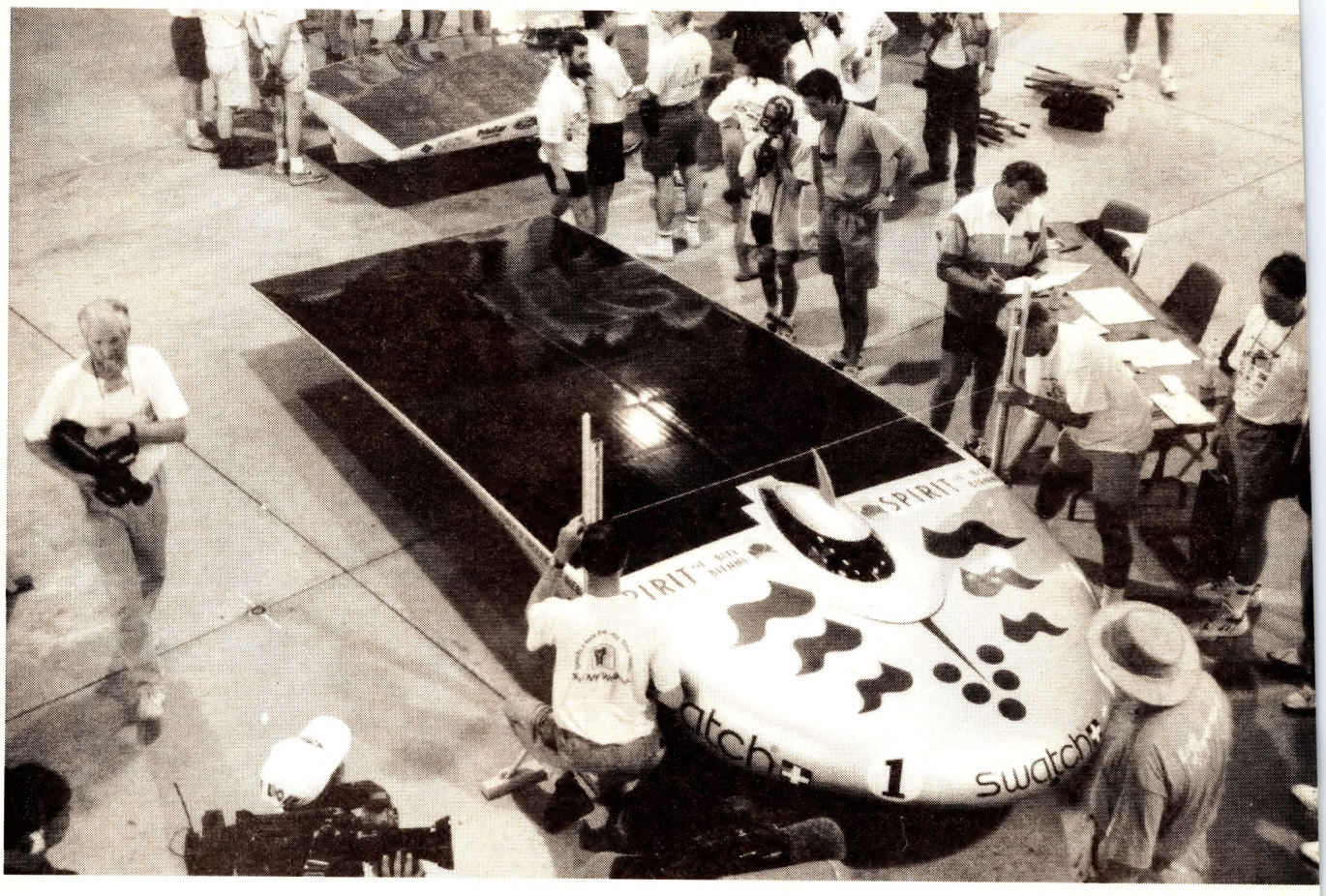
Signature_____ Card expiry date____/____

Books Required (please tick)

- ❑ Newnes Guide to Satellite TV ($45.95)
- ❑ Optoelectronics: An Introduction ($55.95)
- ❑ Linear Electronic Design ($45.95)
- ❑ Digital Audio & Compact Disc Technology ($59.95)
- ❑ Power Electronics Handbook ($59.95)
- ❑ Newnes Guide to TV & Video Technology ($39.95)

Mail coupon to: Silicon Chip Publications, PO Box 139, Collaroy NSW, Australia 2097.

Or call (02) 979 5644 & quote your credit card details; or fax the details to (02) 979 6503.



Darwin to Adelaide: a new speed record of 85km/h

The 1993 World Solar Challenge was won by Honda, slicing almost nine hours off the time of the last race & achieving an average speed of 85km/h for the 3003km race.

By BRIAN WOODWARD

Honda's win came about due to progress in solar cells, power management, electric motor and tyre design and is representative of the great strides forward since the 1990 race.

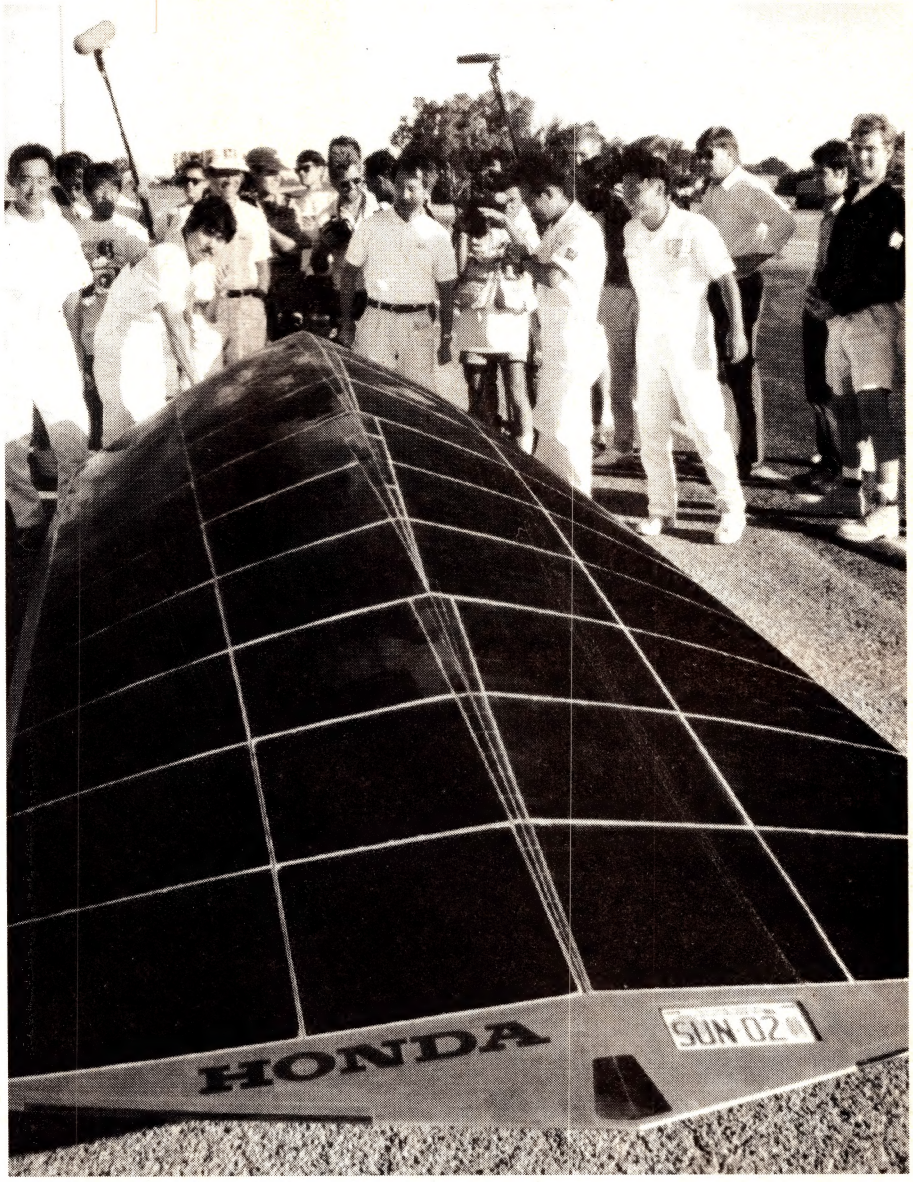
Professor Martin Green of the University of New South Wales is acknowledged to make the best solar cells on earth but a relative newcomer, Richard Swanson of SunPower Corporation, can be confirmed as the maker of the best silicon cells for solar race cars.

It was Richard Swanson's cells which helped win the third World Solar Challenge for Honda. The secret to the cells' design was hidden in a simple sentence or two on the specifications sheet published by Honda shortly before the race.

Rumours abounded that Honda had bought a complete set of race cells (more than 20% efficient) from Professor Martin Green in Sydney at a cost of more than $1.2 million. The price may be subject to doubt but the fact isn't. Honda did buy the cells but used them for a 'mule' (a mule is a test-and-discover race car built for trials before the real car turns a wheel in anger).

The cells used on the race car which appeared for scrutineering a few days before the November 7th race day were

IGHT: HONDA'S winning *Dream* ar sliced nearly nine hours off the ecord & recorded an average speed f 85km/h over the 3003km distance. 'he second placegetter, the *Spirit of iel*, is shown on the facing page at eft. Both cars used brushless hub notors.



sourced from a relatively new US company, SunPower Corporation, which was not named at the time. They were described as "intrinsic monocrystalline silicon cells with back surface contacts . . . laminated with a silicon polymer and covered with a textured acrylic sheet. This sheet is fabricated with parallel angled grooves to enhance energy collection at low angles of solar incidence."

Fresnel lens

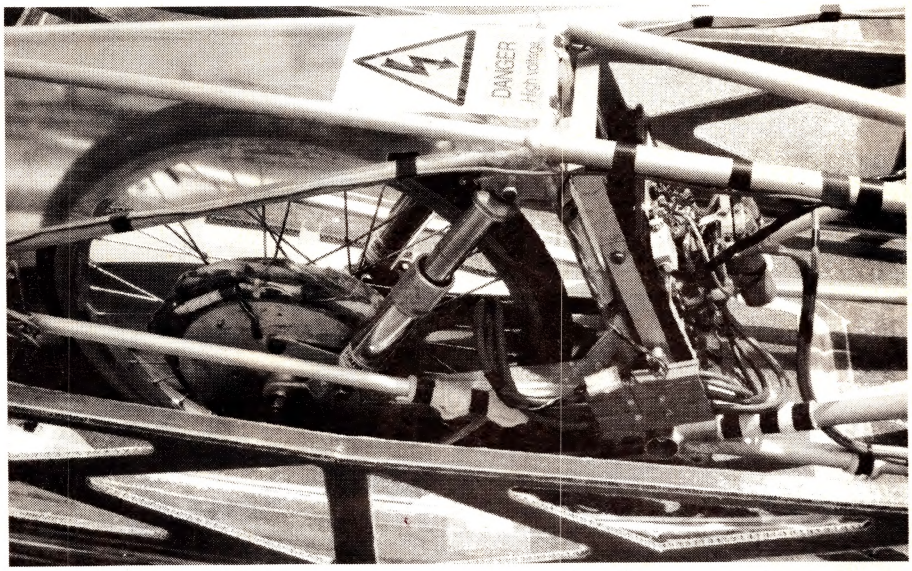
What the description didn't explain was that the 'parallel angled grooves' actually comprised an elaborate Fresnel lens of varying angle. This meant that in the early morning and late afternoon, the sun's rays were diverted by the lens to hit the cells at the optimum angle. For best output, solar arrays are turned until they are perpendicular to the sun's rays. This isn't practical with a solar race car because of poor aerodynamics, but this factor has been ignored by cell makers, up till now.

SunPower made a solar array for the 1993 World Solar Challenge and Honda's claim of more than 1500 watts from eight square metres was beaten on several days when ideal conditions saw almost 1700 watts generated. The array weighs only 19.5kg.

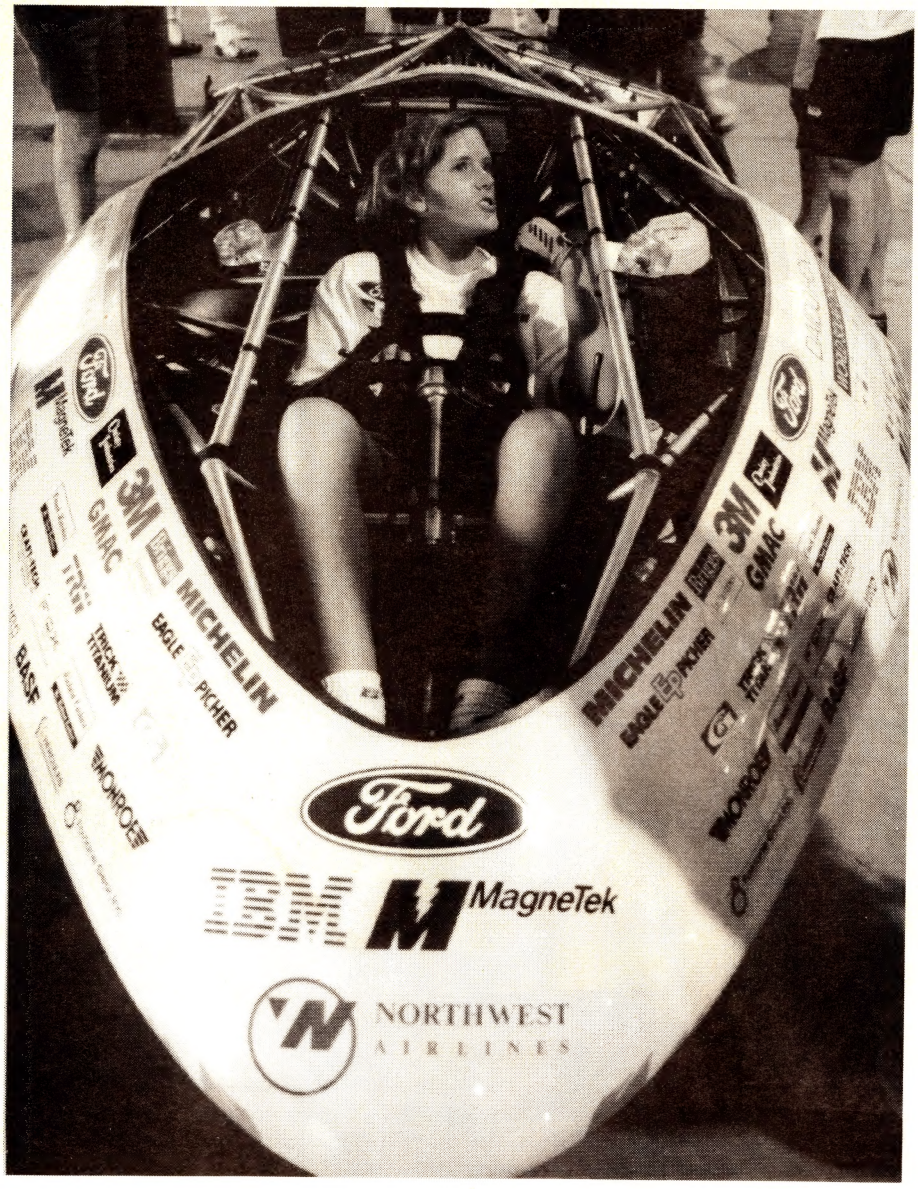
The array used by the Engineering School of Biel was developed by Deutsche Aerospace and proved to be almost as effective as in the Honda *Dream*. The car's better aerodynamics were offset by the compromise angle of the array facing the sun. Naturally, it was best during the middle of the day.

Inoue and Michelin both developed tyres which reduced rolling resistance by 30%. At low speeds, a solar race car spends almost one third of its power simply rolling along the road. A 30% reduction is significant.

Getting the most efficient array's power to an efficient motor in the



THIS CLOSE-UP VIEW shows the brushless DC hub motor used in the Northern Territory University's *Desert Rose*. The motor is controlled by a power management computer & has a claimed efficiency of 96%.



LEFT: THE *Spirit Of Biel* with its solar array raised to recharge its batteries at the end of a day's run. Below: the cramped cockpit in the University of Michigan's car.

most efficient manner has been the bane of solar race car designers since the first race in 1987. With arrays at 20% and motors usually at 83-85%, losses in the tracking and motor management systems are to be avoided.

The big breakthrough

The big breakthrough for 1993 was the brushless DC motor-in-hub. Three cars, the *Spirit of Biel*, the Honda *Dream* and the Northern Territory University's *Desert Rose* all used a hub motor designed to run at 900-1100 RPM with every individual winding addressed by a very busy power management computer.

The Honda *Dream's* motor had a claimed efficiency of 95%, the *Desert Rose's* 96% and the *Spirit of Biel's* 97%. All lost about 1.5-2.5% in the tracking and motor controlling computers. Compare this with a best of around 83% from the 1990 race winner and you can see why so much excitement was generated. It is highly likely that this motor design will become the electric car motor of the future.

The Honda Dream motor had a claimed efficiency of 95%, the Desert Rose 96% & the Spirit of Biel 97%. All lost about 1.5-2.5% in the tracking & motor controlling computers.

The effectiveness of power management in solar race cars is such that, at the Speed and Stability test day in Darwin, Biel claimed the *Spirit of Biel* would achieve 130km/h. It managed 129.9km/h. Honda claimed that its energy balancing computer system predicted an average speed of 86km/h. Over 3003km (even allowing time for flat tyres), Honda's car achieved 84.96km/h. As it turned out, both estimates were amazingly close. **SC**

What's New In Car Electronics?

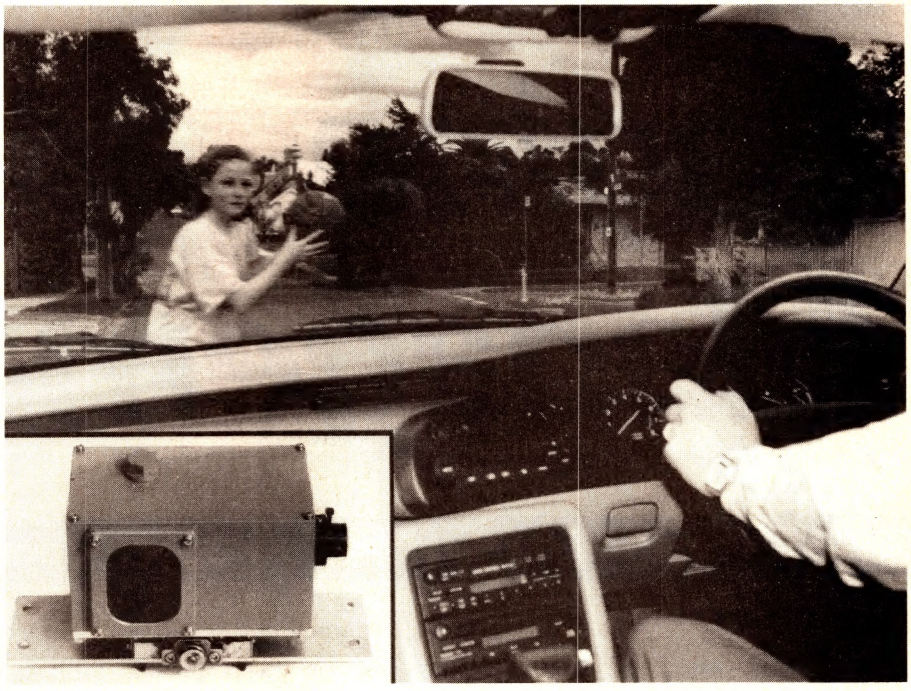
Mazda's Collision Avoidance System

Japanese car manufacturer Mazda has developed a laser-based collision avoidance system for use in passenger vehicles. Using a laser which scans ahead of the vehicle across a 23° range, the system indicates objects potentially in the collision zone.

The system can detect vehicles from approximately 140 metres away and pedestrians from 35-60 metres, depending on their clothing colour and material. It basically detects object movement and from this determines the speed and direction of the object.

When the system detects an object in the "caution zone" a warning buzzer sounds. Should the driver not respond and the object subsequently enters a "danger zone", the vehicle's brakes are applied.

For example, the system would indicate a potential collision with a pedestrian when 30 metres from the person and would apply the brakes when the car was 20 metres away.



At this stage the system is not available in any Mazda car currently on sale, although it is envisaged that the system will be fitted to production cars in the future. **SC**

4pc. Precision Tool Set

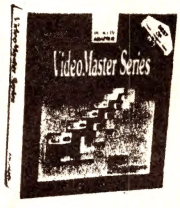
$89.95 plus $7 p+p

Kit contains:
- ★ Vernier Calliper - 200 x 0.05 mm
- ★ Micrometer - 0 to 25 x 0.01 mm
- ★ Steel Ruler - 150 mm
- ★ 90 deg. Knife Edge Square
- ★ All housed in a handy case.

VGA to TV CONVERTOR

This handy active convertor allows you to transfer your IBM compatible screen display (VGA) up onto a large screen television. Ideal as a business presentation tool, educational aid, lectures or simply link up to your PC or laptop to enable a larger screen when playing games.

- ★ Supports PAL system TV sets.
- ★ Anti-Flicker control.
- ★ Supports 320 x 200 res. - 256 colours.
- ★ Input: Analogue RGB from PC VGA card.
- ★ Output: PAL, Video, S-Video, VGA out.



Now $499.00 plus $9 p+p

Information sheet available

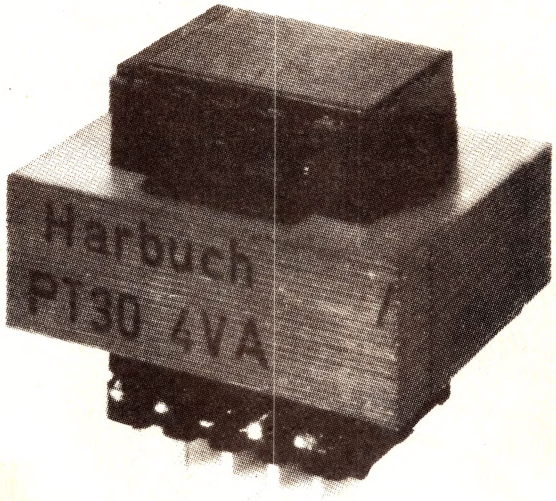
Mailorders Welcome

David Reid Electronics Pty. Ltd.
ACN: 001 372 372

127 York St, SYDNEY 2000
PO Box Q103, SYDNEY 2000
Phone: (02) 267 1385
Fax: (02) 261 8905

E. A. O. E.

PCB POWER TRANSFORMERS



Proudly manufactured in Australia by

HARBUCH ELECTRONICS Pty Ltd

9/40 Leighton Pl, Hornsby NSW 2077

Ph:(02)476 5854 (02)482 7241 Fax:(02)476 3231

VISA bankcard Master

Electronic Engine Management

Pt.4: Changing The System – *by Julian Edgar*

There is a widespread perception that a modern engine managed car is not open to engine modifications; that this type of system is signed, sealed and delivered. To some extent, this is true. Manufacturers leave little adjustment capability in an electronic engine management system, with often only the idle mixture and ignition timing open to change. In some cars, even these – ostensibly, at least – are non-adjustable.

In a standard car, there are good reasons for this approach. With exhaust gas oxygen feedback loops in operation, immediate ECM recognition of sensor failure, and limp-home modes of operation, the last thing that the manufacturer wants is someone armed with a screwdriver and a hammer deciding that the car needs a tune-up! A modern car might not need the mixture adjusted even once in 150,000 kilometres, for example.

For those who like to tinker with their cars – to gain more power by fitting twin carbies, for example – the old days seem to be over.

However, as with previous automotive technologies, there are ways of getting an electronic system to do as you want. Basically, there are four different approaches which can be taken:

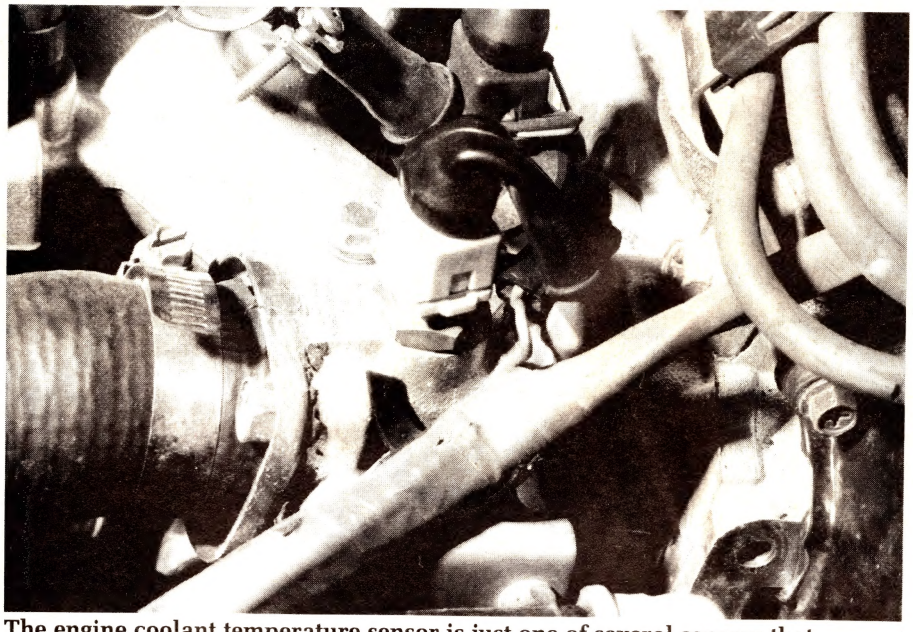
(1). The engine management system can have new inputs fed into it, thus giving changed outputs.

(2). The system can have mechanical, electrical or electronic additions made to it.

(3). The original manufacturer's software can be changed – ie, the chip can be rewritten.

(4). The original ECM can be removed and replaced with an after-market, fully programmable engine management computer.

In this feature, we'll look at the first two methods – crude, often effective and always cheap!

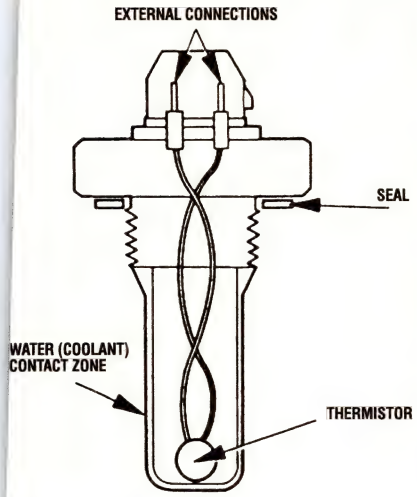


The engine coolant temperature sensor is just one of several sensors that provide information to the ECM. This ECM input is one of the easiest to fool.

The need for modification

But why would you want to modify the engine management system, anyway? A turbocharged car is probably easiest to understand in this context, because the power produced by the engine is so easily increased.

A naturally aspirated engine has air pushed into it by atmospheric pressure – through the air filter, past the throttle butterfly, into the plenum chamber, down the cylinder runner,



ig.1: basic construction of a typical oolant temperature sensor. A hermistor is used as the sensing lement.

If data showing the sensor's temperature/resistance relationship is not available, then some testing with hot water, a thermometer & a multimeter will soon reveal its characteristics.

past the inlet valve and then (finally) nto the cylinder. As the piston sinks on its intake stroke, a partial vacuum s created within the cylinder, and one bar of atmospheric air pressure does the pushing.

The amount of air that the engine inhales depends on its size, on how much flow loss is experienced by the air on its torturous path into the cylinder, and how quickly the engine is rotating (its rpm). However, if the air pressure is raised above atmospheric by a turbocharger or supercharger, then greater flows will occur. With extra fuel added, more power will be produced.

The induction pressure above atmospheric which the turbo produces (called turbo boost pressure) greatly influences the air mass passing into the engine. Manufacturers are often conservative in their boost pressure, generally using around 0.5 bar (about 7 psi). However, most turbo engines will happily cope with 0.7-0.8 bar without mechanical modification.

The problem comes when the volume of air passing into the engine is much greater than the manufacturer designed the EFI (electronic fuel injection) system to cope with. To some extent, the system will self-compensate for changes. The airflow meter will signal the greater air mass flowing to the ECM and this in turn will control the injector pulse width to

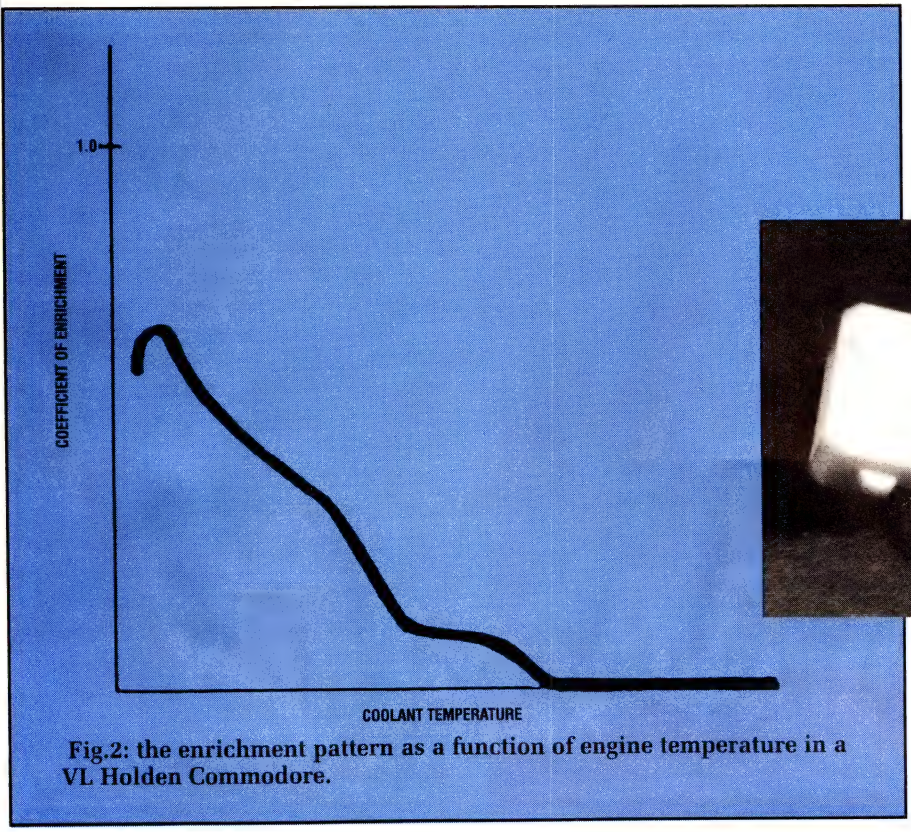
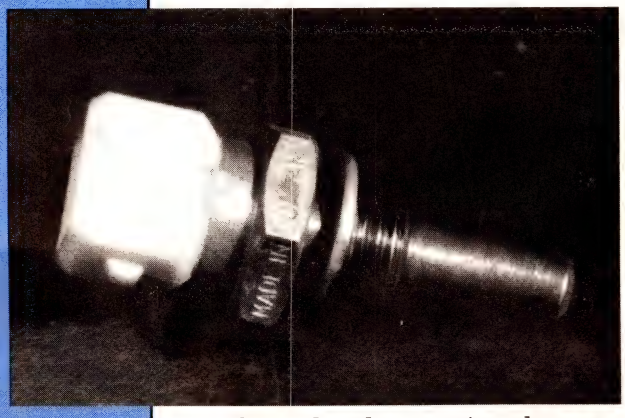
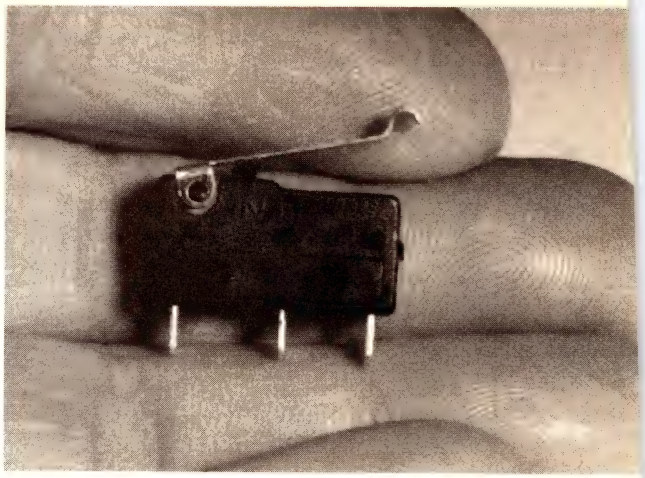


Fig.2: the enrichment pattern as a function of engine temperature in a VL Holden Commodore.



Above: this close-up view shows a typical coolant temperature sensor. It is usually mounted close to the thermostat.

A resistor or potentiometer wired in series with the coolant temperature sensor will cause the ECM to provide more fuel – a very cheap modification.



A microswitch can be used to cause full-throttle enrichment to occur at an earlier throttle opening than normal.

give the appropriate mixture. However, if the airflow is increased too far, the stage will be reached where the mixture starts to become lean – with not enough petrol being mixed with the air. In this situation, the injectors may be held open continuously but their flow rate may be insufficient.

Other causes of increased induction flow which may cause leaning-out include traditional "hotting-up" methods like larger exhaust systems, head modification by bigger valves, and so on.

Fooling the ECM

The ECM computes injector pulse width on the basis of its inputs and on its internal base fuel figures. If the coolant temperature sensor indicates that the engine is cold, then more fuel will be injected – the equivalent of a choke in a car with a carburettor. Similarly, if the throttle position switch (TPS) indicates that your foot is hard down, then the mixture will be slightly enriched to give maximum engine power.

If any conditions which would cause the ECM to enrich the mixture are artificially created, then the fuel flow into the engine will be increased, assuming that maximum fuel flow isn't already occurring.

Probably the easiest sensor input to fool is the coolant temperature sensor. This sensor consists of a thermistor located in the engine cooling system, usually close to the thermostat. Fig.1 shows an example of a coolant temperature sensor. In Fig.2, the pattern of enrichment which the ECM carries out in response to low engine temperature is shown for a VL Holden Commodore.

As the coolant temperature rises, the resistance of the sensor decreases. A typical coolant temperature sensor has the following characteristics:

0°C	6000 ohms
20°C	2500 ohms
30°C	1800 ohms
40°C	1200 ohms
70°C	450 ohms
90°C	250 ohms
100°C	190 ohms
110°C	110 ohms

If a 5kΩ pot is placed in series with the sensor, then the ECM can be easily persuaded that the engine coolant temperature is anything from 0°C to its real value! Feeding information to the ECM which understates the actual temperature of the coolant will cause the mixture to become richer than it otherwise would be. More fuel will be injected as the ECM program tries to overcome the expected cold-engine affects of poorer fuel atomization, thicker oil, and so on.

However, while enrichment may be quite substantial at some rpm settings, it's unlikely that the ECM was designed with the idea that the engine will be revved at 6000rpm with the coolant temperature at 5°C! Cold-start enrichment usually declines with increasing load and/or rpm. On the other hand, if the engine runs slightly lean throughout its rev range (because of engine modifications), then a potentiometer in series with the cold-start sensor can be a very good starting point in overcoming it.

If full throttle enrichment is wanted earlier in the throttle opening, then a microswitch operated by the rotation of the throttle shaft can be used to trigger this input – a function usually

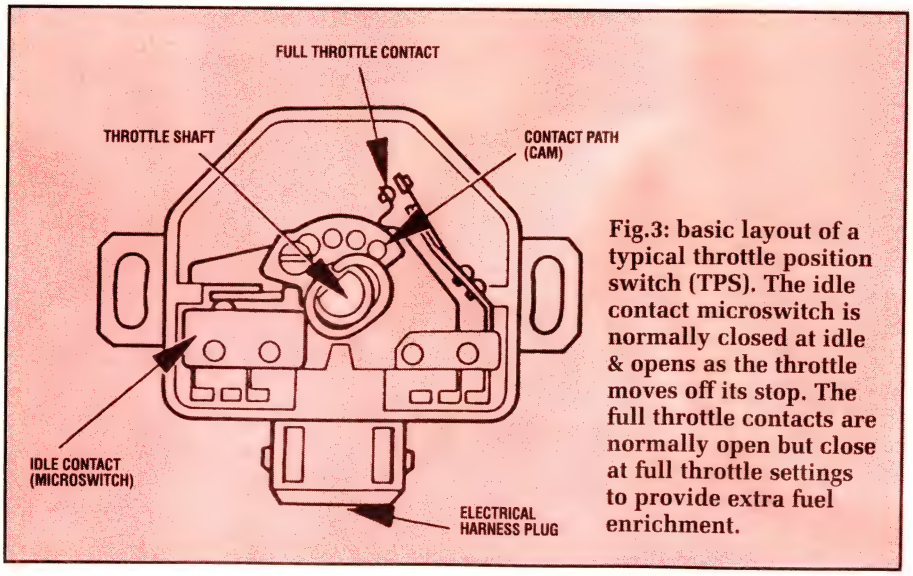


Fig.3: basic layout of a typical throttle position switch (TPS). The idle contact microswitch is normally closed at idle & opens as the throttle moves off its stop. The full throttle contacts are normally open but close at full throttle settings to provide extra fuel enrichment.

provided by the throttle position switch (TPS). Fig.3 shows a typical TPS.

The correction coefficient used with the base fuel figures increases with increasing rpm – and the final correction step is inducted by the throttle position switch. Other sensors with the potential for deliberate misuse include the knock sensor (to retard timing), the airflow sensor (to change mixtures), the vehicle speed sensor (remove speed limiter), the MAP sensor (remove turbo over-boost fuel cut-off), and the induction air temperature sensor (change mixtures).

Extra Injectors

If the injection system provides insufficient fuel flow at full load, then extra fuel injectors can be added. The most sophisticated way of doing this is to control the extra injector by the use of a commercially-made supplementary injection computer, which has various inputs to monitor load and rpm. However, because full load usually coincides with maximum airflow, the accuracy with which fuel mixtures must be held for good performance is fairly low.

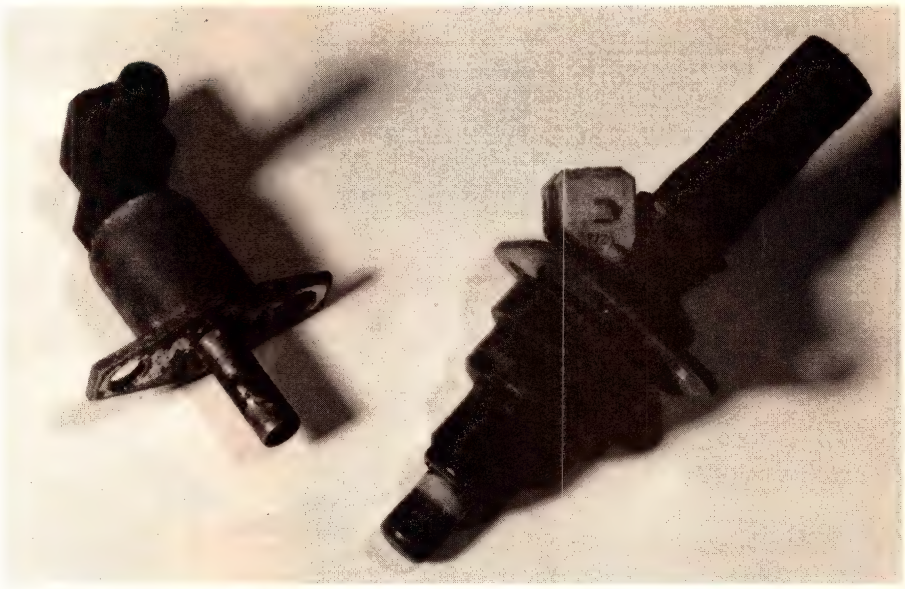
An extra injector can be mounted prior to the plenum chamber to promote good fuel mixing and can be wired in series with one of the normal injectors. To prevent it from enriching the mixture constantly, it needs to be switched on and off. In a turbocharged car, the simplest way of achieving this is to use a pressure switch which is mounted on the plenum chamber. Adjustable pressure switches – under the Hobbs brand name – are available from automotive instrument suppliers.

However, switch-on of the injector can be triggered in a more sophisticated manner by monitoring one or more of the standard engine management sensors. By using voltage comparators, the airflow meter and throttle position switch could be monitored, with the extra injection occurring only at high gas flows and wide throttle openings.

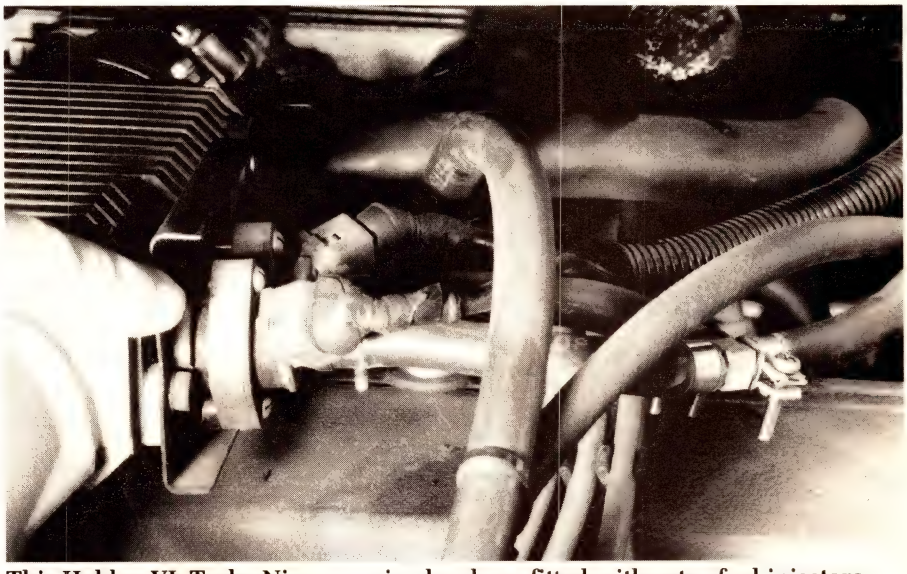
Of course, the extra injector does not come on stream gradually with this system. Instead, the mixture undergoes a sudden enrichment by 10-20% (depending on the supplementary injector size). To overcome this, a circuit can be made up which duplicates the commercially available injection computer by increasing supplementary injector pulse width in response to greater gas flow, etc. In prtactice though, this is not always needed. Another approach is to use two sequentially-operated low-capacity supplementary injectors.

The extra injector load placed on the output transistors of the ECM doesn't appear to cause problems, although the supplementary injectors should be of the same resistance as the original injectors. The power capability of the ECM output transistors may also vary from computer to computer.

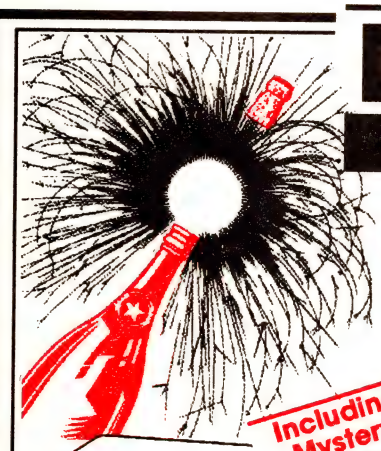
With extra injectors available cheaply from wreckers of Japanese engines (about $10 each), a supplementary injection system can be added for very low cost. The final mixtures should always be checked. The best way to do this is to use a chassis dynamometer in conjunction with a four-gas exhaust analyser. Another (cheaper) method is to build an oxygen sensor output meter and closely monitor the mixtures in real driving conditions. **SC**



Ancillary injectors can be used to provide more fuel if the original injectors prove to be inadequate after engine modifications. The injector on the left is a cold-start injector, while at right is an injector from a 4-cylinder Nissan engine. The typical cost from a wrecker would be $10 each.



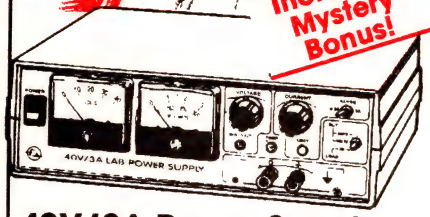
This Holden VL Turbo Nissan engine has been fitted with extra fuel injectors which, along with other modifications, provide a 50% power boost. The additional injectors are triggered by manifold pressure switches & are pulsed by the standard computer.



DICK SMITH ELECTRONICS

Quality Kits For 1994!

Including Mystery Bonus!



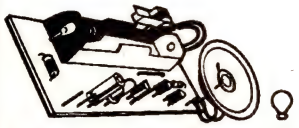
Get All Your Power From One Supply!

NEW

40V/3A Power Supply

A strong power supply for your benchtop! While this power supply is of relatively simple construction, it provides an output voltage of 0 to 40V (0 to +/-20V), output current of up to 3.5A and current limit of approx. 30mA to 3.5A in two ranges and features meters for both voltage and current readings. It offers full electrical and thermal overload protection and, unlike most power supplies, lets you choose between single or dual-tracking supply and adjust the current limiting. Also includes output load switching, current setting switch and a dropout indicator. Complete with all components, hardware, PCB, case and pre-punched screened front panel.

EA Jan '94 K-3206 **$169**



Make Your Own Doorbell Or Great For School Projects!

Melody Generator Kits

Create the most unique doorbell or project of all with a sound generator kit. With a choice of 6 different ICs, you can produce a 64 note melody using just a 3 pin IC, a PCB and a few external parts. Powered by just a single 1.5V battery (not supplied) you'll be astounded by the sound generated by the mini speaker. You'll also find the kit great when inserted into toys or included in your own projects. Each kit comes complete with a melody IC, battery holder, PCB and all external components.

Christmas melody
Cat K-5502

Home Sweet Home
Cat K-5504

Wedding March
Cat K-5506

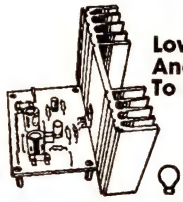
Fur Elise
Cat K-5508

The Waltz
Cat K-5510

Mary Had A Little Lamb
Cat K-5512

$9.95 ea.

Silicon Chip Dec'93



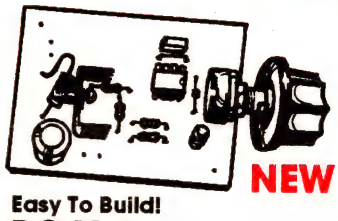
Low-Cost And Easy To Build!

25 Watt Amp Module

You'll save both time and money assembling this audio power module! It's a very simple, yet extremely versatile circuit based on a single IC. It produces 25W RMS into 8 ohms and 20W RMS into 4 ohms and, with a signal-to-noise (S/N) ratio of 110dB and a distortion figure of just 0.025% for 1kHz at 20W. Using a pair of modules, it'd be the ideal basis for a hi-fi stereo amplifier. The unit also offers internal short-circuit protection & inbuilt thermal protection. The module will be supplied in short form with all components, PCB and heatsink.

Cat K-5602 **$29.95**

Silicon Chip Dec '93



NEW

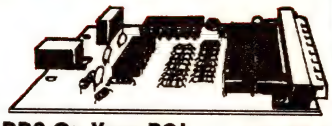
Easy To Build!

DC Motor Controller

Using just one 555 timer IC, this simple kit can control 12V DC mini drill motors or lights with currents up to 1 amp. It contains just a few components and employs the pulse-width modulation (PWM) technique to send bursts of current to the motor, providing an efficient means of varying motor speed. Comes in shortform, with all components, PCB and mini heatsink for the switching transistor.

K-3070 **$10.95**

Silicon Chip Jan '94



NEW

DDS On Your PC!

Direct Digital Synthesiser

This kit is great for experimenting with or demonstrating the principles of direct digital synthesis (DDS). Using software on your PC, it's both inexpensive and easy. It simply connects to your PC's printer port and generates precision frequencies in the audio range (from 1Hz to approximately 12kHz - depending on the speed of your PC). Its output can be either sine, square, sawtooth, triangle or virtually any repetitive waveform. Comes in short form with all components, PCB & Software (3.5" disk).

Cat K-7344 **$22.95**

EA Jan '94

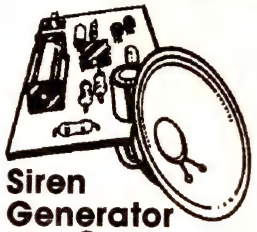
The Most Efficient Light Of All!

18/36 Watt Fluorescent Inverter

A very efficient source of light, this inverter powers either an 18W or 36W slimline fluorescent tube from a 12 volt battery. Perfect for camping, caravans, emergency light or as part of a solar powered lighting installation for remote areas. It offers a light output equal to conventional mains powered lamps, fast start (without flicker), pre-heated filaments, reverse polarity fuse protection as well as fuse protection for faulty tubes. Comes in shortform, complete with all components, hardware, PCB and transformers (ie cores and formers).

Cat K-3004 **$69.95**

Silicon Chip Dec '93



Siren Generator Kit

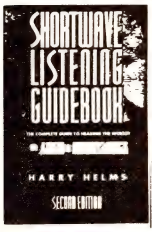
A simple kit that provides three loud siren sounds! Just a flick of a switch will sound either police, ambulance or fire engine sirens. With just a slight alteration, you can also get it to emit the sound of a machine gun firing. Operates on just one "AA" battery (not supplied). Comes with all components, PCB, battery holder and speaker.

Cat K-5514 **$9.95**

Silicon Chip Nov '93

Please contact your nearest store for availability as some kits may still be in production.

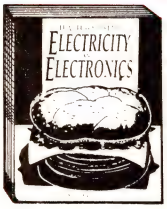
Food For Thought!



NEW
Cat B-2042
$29.95

'Shortwave Listening Guide' 2nd Edition For 1994

The whole world's talking on shortwave radio and this up-dated book tells you how to listen in! It contains everything you need to know about shortwave; selecting the right shortwave radio, how to operate a shortwave radio correctly, profiles of international stations and more!



NEW
Cat B-1622
$49.95

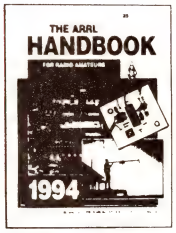
Teach Yourself Electricity And Electronics

A complete self-teaching guide offering over 1000 practice test questions and solutions. It covers a wide range of topics and includes circuit diagrams and chapter review quizzes to help you along the way.

NEW
Cat B-6750
$59.95

Instant Multimedia For Windows 3.1

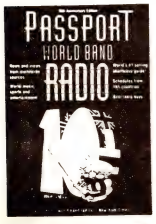
An easy-to-understand introduction to the concepts of multimedia computing and its potential. You'll discover that you don't need to add expensive equipment or special equipment to enjoy its benefits. Includes two feature-packed diskettes.



NEW
Cat B-2227
$49.95

The 1994 ARRL Handbook

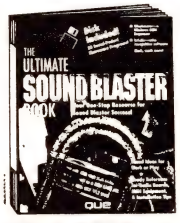
Brings you up-to-date with what's new in Amateur Radio. Includes a reference guide, a range of easy-to-follow construction projects, a guide to radio theory and much more!



NEW
Cat B-2053
$39.95

Passport To World Band Radio '94

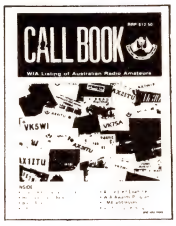
Essential for anyone who's getting started with a shortwave receiver. It's been updated for 1994 and offers a wealth of information on what's on shortwave radio, how to get the best from your listening and more.



NEW
Cat B-6712
$69.95

The Ultimate Sound Blaster Book

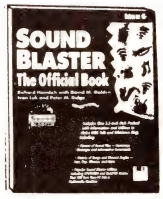
An advanced book for people who want to do more with their Soundblaster cards! It contains detailed information essential for both hardware and software developers and comes with two 3.25" disks containing a host of shareware programs.



NEW
Cat B-2336
$12.50

W.I.A Ham Radio 1994 CallBook

The complete up to the minute listing with valuable information about all members listed on the Wireless Institute of Australia (WIA) database. Covers call signs, suffixes, shortwave, Department of Transport & Communications information and more.



NEW PRICE!
Cat B-6710
$49.95

Sound Blaster - The Official Book

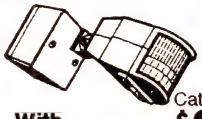
The one and only book endorsed by Sound Blaster's manufacturers Creative Labs, it covers the whole family of Sound Blaster cards including Sound Blaster Pro, the new Sound Blaster 16 and the Soundblaster Multimedia Kit. Comes complete with a 3.5" disk packed with information and utilities.

Cat D-2847
$269

Sangean ATS-606 AM/FM/LW

Top Performing Shortwave Receiver

The easy way to listen in to shortwave, AM or FM! Offers simple keypad frequency entry, push-button selection of the 45 station memories, a scanning facility plus, its back-lit LCD screen keeps you informed of all functions currently selected. Complete with dual-alarm, sleep and dual-time facilities plus earphones for FM stereo.

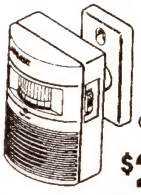


Cat L-5343
$34.95

With Adjustable Time And Range!

PIR Sensor Light Control

Your lights will come on automatically when anyone approaches, making it safer when you come home late as well as deterring intruders. Has adjustable time between 5 seconds and 12 minutes (approx.) as well as adjustable sensitivity and range (up to 15M through 90°). With manual over-nde and a daylight sensor.



NEW
Cat L-5045
$29.95

Mini Alert Alarm Chime

Greet Guests Or Scare Off Intruders!

Set this to operate as an alarm or as a welcome chime! It monitors an 8 metre range in an 80° arc and comes with a low-battery indicator LED and wall mounting bracket.

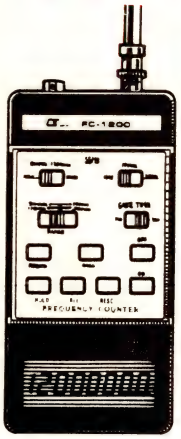
SAVE $10
Limited Stock!
Cat L-5164
$69.95

Ideal For Bikes Or Display Stock!

Alarm Lock Cable

With a vibration sensor switch which triggers an extra loud siren. The alarm will also sound if the steel cable is cut and the tamper switch defends against any attempts to open the battery compartment. Includes 2 security keys, mounting bracket and high-impact weather-proof case.

Test Out This Equipment



1.25GHz Handheld Digital Frequency Counter

Ideal for measuring radio frequency transmissions and servicing stereos, videos, computers and cordless phones. This incredibly easy-to-use 10Hz to 1.25GHz frequency counter has an 8-digit LCD display, data hold, relative measurement and data record (min, max & average). There's also selectable resolution, period measurement and more. Comes complete with telescopic antenna and BNC to alligator clip test leads.

Specifications

Range:	10Hz to 1.25GHz
Impedance:	1M OHM
Accuracy:	+/- (1PPm + 1d)
Range:	Channel A: 500MHz/1250MHz
	Channel B: 10MHz (10Hz to 10MHz)
Max voltage:	Channel A: 5V P-P
	Channel B: 250V p-p

Cat Q-1322

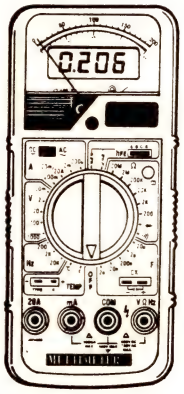
$229.95

Air Speed Turbo Meter

A highly accurate wind speed meter sma enough to fit in the palm of your hand! T Turbo Meter produces an easy to read digital display of wind speed in knots, mi per hour, meters per second or feet per minute. It can be used for a variety of purposes including; boating, aviation, sports and experiments.It's both weather and shock resistant and comes complete with pouch, lanyard and comprehensive instructions. Requires 3 x 'AAA' batteries

Scale	Range Selection
Knots:	0-87.9
Feet per minute :	0-8790
Metres per second:	0-44.8
Miles per hour:	0-99.9

Cat Q-1405 **Save $20!** **$17**



With Analogue Display!

Compact 3.5 Digit Multimeter

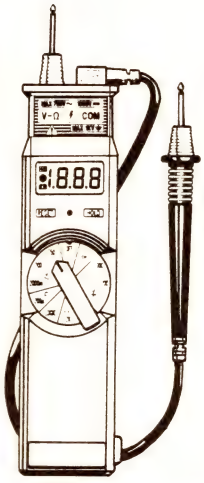
Now, you can read from both analogue and digital displays on the one multimeter! It offers data hold (for analogue display only), high-input impedance and overload protection. Tests capacitance, frequency, transistors, diodes, continuity and temperature.

Specifications:

DCV:	200mV, 2, 20, 200, 1000V
ACV:	200mV, 2, 20, 200, 750V
AC/DC Current:	200uA, 2mA, 20mA, 200mA, 20A
Resistance (ohms):	200, 2K, 20K, 200K, 2000K, 20M

Cat Q-1702

$215



With Data Hold

Pencil-Style Digital Multimeter

Designed especially for electricians and servicemen, this pencil-style meter will provide reliable service in the harshest of environments. It includes a data hold butto bright LED warning lamp and a beeper to warn of dangerous voltages. Other feature include 3.5 digit display, auto-off, logic, dio and continuity test.

Ranges:

DCV:	2, 200, 1000V
ACV:	2, 200, 750V
Resistance:	200ohm, 2Kohm
Capacitance:	200uF

$14

Cat Q-1580

BONUS

Clamp Head Cat-1590

Valued at $39.95

Put Your Mains Circuit To The Test!

AC Voltage Finder

This device detects the electromagnetic field surrounding cables, sensing any AC voltage above 120 volts and warns you with both an LED and an audible "buzz".

Cat Q-1531

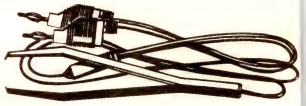
For This Month Only: **$12.95**

Component Test Probe

Great for testing Surface-Mounted Devices or general components such as resistors, diodes and capacitors, this probe lets you apply both contacts with one hand, leaving the other free. Can be used with most digital multimeters and other test equipment with "banana" type socket inputs.

Cat Q-1932

$12.95



MAJOR DICK SMITH ELECTRONICS AUTHORISED STOCKISTS:

NSW ARMIDALE: New England Electronics 711 655 **BALLINA:** Ballina Electronics 867 022 **BATEMAN'S BAY:** Baycity Sight & Sound 725 030 **BATHURST:** Electronic Frontiers 323 933 **BOURKE:** Countrywide Services 722 150 **BOWRAL:** Bowral Electrical Suppliers 611 861 **BROKEN HILL:** Hobbies & Electronics 884 098 **COOTAMUNDRA:** Cootamundra Music & Light 422 561 **DENILIQUIN:** Deni Electronics 813 672 **DUBBO:** Chris's Hi Fi 828 711 **GOULBURN:** Tunlive 221 288 **GRAFTON:** Repairs & Spares 421 911 **GRIFFITH:** Miatronics 624 534 **GUNNEDAH:** Carter's Sportscene & Electronics 42 2230 **INVERELL:** Infolink Computer Systems 513 131 **KATOOMBA:** Niagara Photo & Sports 822 800 **KEMPSEY:** P & K Richards 631 134 **LEETON:** Leeton Audiotronic 532 800 **LIGHTNING RIDGE:** Lightning Ridge Solar Power 291 013 **LISMORE:** Decro Electronic Services 321 896 **LITHGOW:** Douroy Photographics 513 173 **MACKSVILLE:** Macksville Electronics 682 899 **MOREE:** Moree Electronics 522 091 **MUDGEE:** Headwear 723 895 **MURWILLUMBAH:** Strings & Things 723 684 **NARRABRI:** Namoi Computer Service 923 274 **NELSON BAY:** Nelson Bay Elect. & Hobbies 813 685 **NOWRA:** Nowra Electronics 210 722 **PARKES:** Strad Music Centre 623 366 **PORT MACQUARIE:** Port Electronics 836 875 **RICHMOND:** Silicon Crafts 784 101 **TAREE:** Manning Electronics 512 233 **TUNCURRY:** Tuncurry Electronics 545 006 **ULLADULLA:** Coastal Electronics 553 989 **WAGGA WAGGA:** Phillips Electronics 216 558 **WALGETT:** Walgett Electronic Centre 281 111 **WINDSOR:** Hawkesbury Electronics 776 722 **YASS:** Warmington Electrical 261 411 **YOUNG:** Keith Donges 821 279 **VIC ARARAT:** Jerram Electronics 522 345 **BAIRNSDALE:** Green Gage Services 525 677 **BENALLA:** North East Electronics 622 710 **CASTLEMAINE:** Inspect Electrics 723 773 **COLAC:** Colac Electronics 312 847 **ECHUCA:** Gilmour Electronics 822 956 **HORSHAM:** Burgess Camera House 81 1680 **MILDURA:** Pullman Auto Pro 232 882 **MORWELL:** Roylaine Pty Ltd 339 458 **ROSEBUD:** Seatech Vic Pty Ltd 822 225 **SHEPPARTON:** Andrew Guyatt Electronics 219 497 **SWAN HILL:** Nyah District TV Service 329 303 **ST. ARNAUD:** Whartons Appliances 951 069 **WARRAGUL:** Roylaine 234 255 **WARRNAMBOOL:** Koroit St. Elect. Services 627 417 **WONTHAGGI:** South Gippsland Photo Service 721 411 **QLD AYR:** Delta Electrix 831 566 **BOWEN:** Plaza Electronics 863 477 **BUNDABERG:** Bob Elkin Electronics 521 785 **CALOUNDRA:** Electro-mart 918 533 **DALBY:** Hobby & Electronics 625 770 **GLADSTONE:** Electronic Enterprises 726 660 **GOONDIWINDI:** CTW Electronics 713 411 **INGHAM:** Masons Electronics 763 188 **INNISFAIL:** Innisfail Hi-Fi 612 014 **KINGAROY:** MD & MM Siegle 624 535 **MACKAY:** Steven's Electronics 511 723 **MARYBOROUGH:** Keller Electronics 214 559 **MOSSMAN:** Mossman Electronics 982 200 **MT. ISA:** Outback Electronics 433 331 **PIALBA:** Keller Electronics 283 749 **STANTHORPE:** Granite Belt Communications 813 333 **TAS BURNIE:** Electronic City 314 760 **DEVONPORT:** Al Electronics 248 322 **SA MT. GAMBIER:** Hutchesson's Communication 250 400 **PORT LINCOLN:** Basshams TV & Comp. World 830 075 **WHYALLA:** Eyre Electronics 454 764 **WA ALBANY:** Micro Electronics 412 077 **BUNBURY:** Micro Electronics 216 222 **GERALDTON:** Angora Lighting 211 278 **MANDURAH:** Mandurah Hi Fi 581 2206 **MARGARET RIVER:** CPA Electronics 573 888 **PORT HEDLAND:** Ivan Tomek Electronics - Retail 732 531

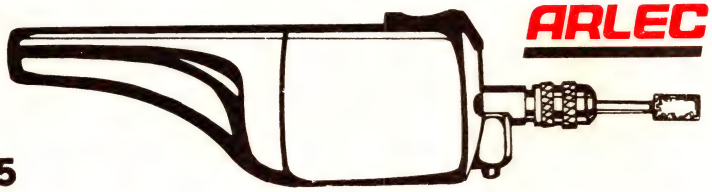
For An Easier Day's Work!

Arlec Super Tool

PCB Work Made Simple And Economical

If you want to save time and frustration when working on PCBs, work with the Arlec super tool! It's an extremely high quality and reliable tool that operates on a safe low voltage. You'll find it great for sanding, polishing, drilling, engraving, milling and more! Plus, everything you need for highly-efficient work is provided including: Wire brush, milling cutters, grinding wheel, high speed drills, chuck collets, eraser sticks and mains plug pack adaptor. Comes complete with a handy, go-anywhere plastic carry case!

Cat T-4754



$84.95

Available Soon!
Ceramic Adjusters

You'll find these high quality adjusters perfect for computers, communication instruments, VCR, CD and other electronic devices. They're made from a combination of high-tech-materials with zirconia ceramic blades and anti static handles. Plus, they're non-conductive, non magnetic, non static and long-lasting.

Cat T-5200	0.9 mm Flat	Cat T-5208
Cat T-5202	1.3 mm Flat	#O Philips
Cat T-5204	1.8 mm Flat	
Cat T-5206	2.0 mm Flat	

Why pay more?

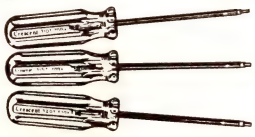
Only:

$14.95 ea.

Torx Screwdrivers
A must For Computer And Appliance Servicing!

Pack of 3 quality torx screwdrivers. Sizes 310, 315, 320.

Cat T-6132



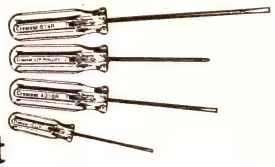
$29.95

Crescent

Low-Cost Multi-Purpose Screwdrivers

Quality 4-piece set of screwdrivers with precision-ground sand-blasted tips for greater accuracy. Made from rust-resistant steel alloy with oil and solvent resistant handles.

Cat T-6130



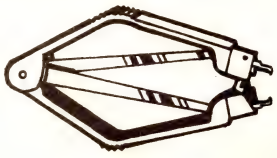
$19.95

Crescent

Available Soon!
PLCC Extractor

Every computer tech needs one! For removing plastic-leaded chips and upgrading computer processors, this extractor makes the job a breeze.

Cat T-4655



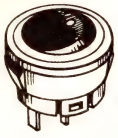
$9.95

Mini SPDT Rocker Switch

NEW

Why spend time trying to drill a square hole? This one requires just one round hole, 19.84mm in diameter and the job's done! Rated at 240V 6A.

Cat P-7701



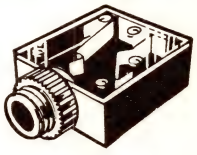
$4.95

3.5mm Stereo Socket

Now in Double Pole! PCB/Panel 1 DPST

NEW

Cat P-1247



$2.35

Inline Bridge Rectifier

Save space with a single in-line rectifier! KBL10/407 SIL 1KV 4A.

Cat Z-3310

$3.95

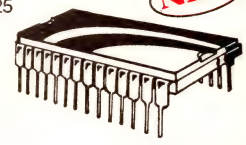
NEW

Philips SAB 6456 1GHz Pre Scaler

Equivalent to Telefunken's U664B.

NEW

Cat Z-9125



$6.95

PHONE, FAX & MAILORDER SERVICE

Outside Sydney (FREE Call) 008 22 6610

Sydney and Enquiries - (02) 888 2105

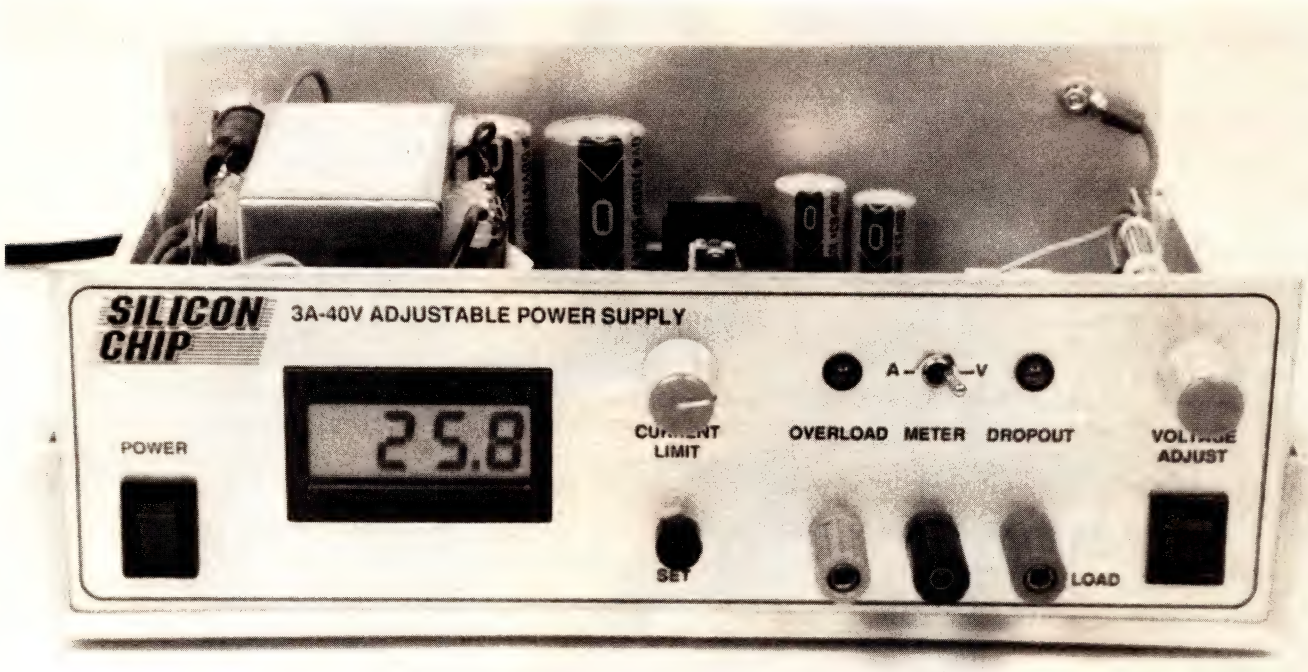
Fax: (02) 805 1986 or write to

Dick Smith Electronics, Mail Orders, Reply Paid 160

PO Box 321 NORTH RYDE NSW 2113

All major Credit Cards accepted. O/Nite Courier Available.

NSW • Albury 21 8399 • Bankstown Square 707 4888 • Blacktown 671 7722 • Bondi 387 1444 • Brookvale 905 0441 • Burwood 744 7299 • Campbelltown 27 2199 • Chatswood Chase 411 1955 • Chullora 642 8922 • Gore Hill 439 5311 • Gosford 25 0235 • Hornsby 477 6633 • Hurstville 580 8622 • Kotara 56 2092 • Liverpool 600 9888 • Maitland 33 7866 • Mid City Centre 221 0000 • Miranda 525 2722 • Newcastle 61 1896 • North Ryde 878 3855 • North Sydney (Greenwood Plaza) 964 9467 • Orange 618 400 • Parramatta 689 2188 • Penrith 32 3400 • Railway Square 211 3777 • Sydney City 267 9111 • Tamworth 66 1711 • Wollongong 28 3800 ACT • Belconnen (06) 253 1785 • Fyshwick 280 4944 VIC • Ballarat 31 5433 • Bendigo 43 0388 • Box Hill 890 0699 • Coburg 383 4455 • Dandenong 794 9377 • East Brighton 592 2366 • Essendon 379 7444 • Frankston 783 9144 • Geelong 232 711 • Highpoint 318 6300 • Melbourne City 399 Elizabeth St 326 6088 & 246 Bourke St 639 0396 • Richmond 428 1614 • Ringwood 879 5338 • Springvale 547 0522 QLD • Booval 282 6200 • Brisbane City 229 9377 • Buranda 391 6233 • Cairns 311 515 • Capalaba 245 2870 • Chermside 359 6255 • Maroochydore 791 800 • Mermaid Beach 785 600 • Rockhampton 27 9644 • Southport 32 9033 • Toowoomba 38 4300 • Townsville 72 5722 • Underwood 341 0844 SA • Adelaide City 232 1200 • Elizabeth 255 6099 • Enfield 260 6088• St Marys 277 8977 • Westlakes 235 1244 WA • Cannington 451 8666 • Fremantle 335 9733 • Perth City 481 3261 • Midland 250 1460 • Northbridge 328 6944 TAS • Glenorchy 732 176 • Hobart 31 0800 • Launceston 344 555 NT • Darwin 81 1977 STORES ACROSS AUSTRALIA AND NEW ZEALAND * STORES IN RED ARE OPEN SUNDAYS.



Build a 40V 3A variable power supply

This 1.23-40V adjustable power supply is designed for heavy-duty work. It uses a high-efficiency switching regulator circuit & features preset current limiting, full overload protection & an LCD panel meter for precise voltage & current readouts.

By JOHN CLARKE

By far the biggest advantage that this elegant new power supply has over other designs is its high-efficiency switching regulator circuitry. In this type of circuit, the regulator is either fully on or fully off at any given instant and so it dissipates very little power, even when delivering high current at low output voltage.

In practical terms, this means that the regulator generates very little heat and so we don't need to use large and expensive heatsinks. And that in turn means that we can greatly simplify the construction and pack the required circuitry into a much smaller case than would otherwise be required for a conventional design employing a linear regulator.

In fact, by employing switchmode operation, the regulator in this circuit generates less than 10W under worst case conditions. By contrast, a linear regulator in an equivalent 40V supply would need to dissipate around 120W when delivering 1.23V at 3A! This is an enormous amount of heat to extract and would require a large finned heatsink to keep the regulator temperature within specification.

This is one power supply that can continuously supply a high output current without suffering from thermal overload problems. By contrast, a linear regulator has inherently high dissipation, especially at very low output voltages (due to the high voltage across the regulator), and this severely limits its output current capability.

Another very commendable feature of the circuit is the low level of ripple and hash in the output. Achieving this is not always easy in a switchmode design but we've done it using a combination of extra filtering and careful circuit layout. As shown in the specifications panel, the output noise and ripple is just 5mV p-p at 24V, reducing to a minuscule 1mV p-p at 3V.

Main Features

- Output voltage continuously adjustable from 1.23V to 40V
- Greater than 3A output current capability from 1.23-28V
- Digital readout of voltage, current or current limit setting
- 10-turn pot for precise voltage adjustment
- Adjustable current limit setting
- Current overload indication
- Regulation dropout indication
- Output fully floating with respect to earth
- Load switch
- Low output ripple
- Short circuit & thermal overload protection
- Minimal heatsinking

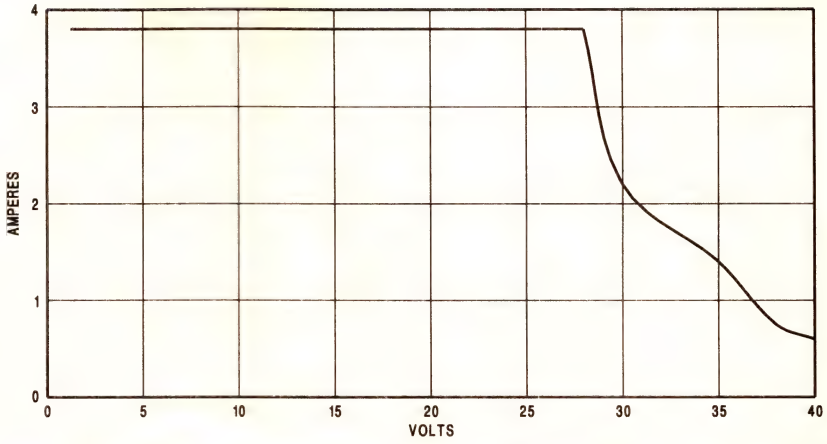


Fig.1: the voltage vs. current characteristics of the supply. It is capable of supplying a hefty 3.8A over the range from 1.23V to 28V. Beyond that, the available output current decreases due to the transformer regulation.

These are excellent figures for a switching design and are comparable to those achieved by linear circuits. The switching hash is also very low. It is far less than in previous designs and, in fact, is below the ripple level.

Digital readout

Do you need to precisely monitor the output voltage or current, or accurately set the current limit? Well, with this power supply you can because it uses an LCD panel meter to give a digital readout of voltage or current. A single toggle switch selects the measurement mode.

A 10-turn pot makes it easy to set the output voltage to the exact value required, while the current limit is set by first pressing the Set button and then adjusting the Current Limit pot until the LCD shows the required value. In addition, there are two LEDs on the front panel and these provide current overload and regulation dropout indication.

There's one other control on the front panel that we haven't yet mentioned – the Load switch. This simply connects or disconnects the load (ie, the device being powered) from the supply rail and eliminates the need to switch the supply off when making connections to the output terminals. It also allows the output voltage and current limit values to be set before power is applied to the load.

Output capabilities

Fig.1 plots the performance of the supply. As shown, it is capable of supplying a hefty 3.8A over the range from 1.23V to 28V. Beyond that, the available output current decreases due to the transformer regulation. However, there is still 2.2A available at 30V, 1.4A at 35V and 600mA at 40V.

The load regulation is excellent at the higher voltages but is not as good

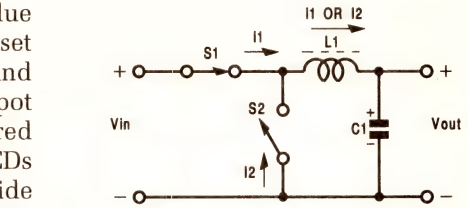


Fig.2: how a switching regulator operates. When S1 is closed & S2 is open, current flows to the load via L1 which stores energy. When S1 subsequently opens & S2 closes, the energy stored in the inductor maintains the load current until S1 closes again.

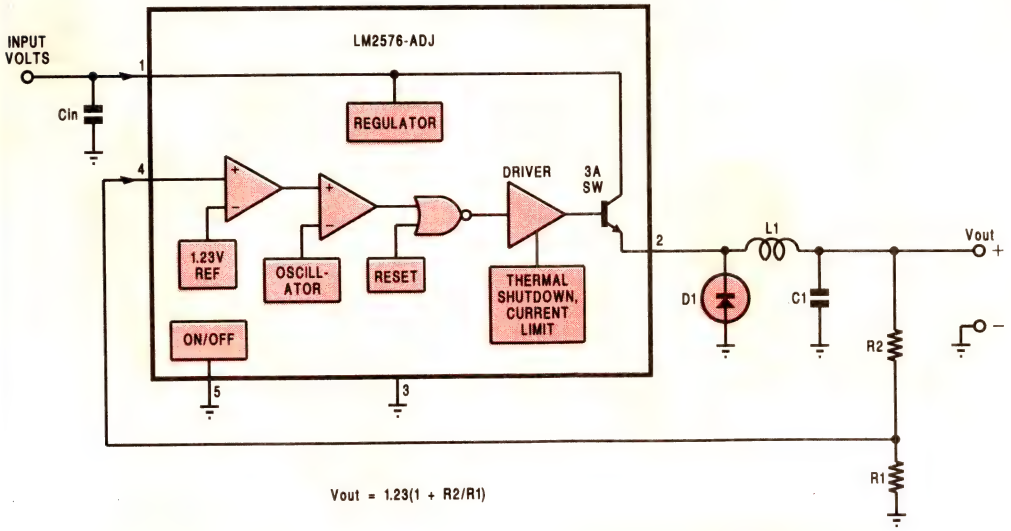


Fig.3: a basic switchmode voltage regulator based on the LM2576 IC. In this circuit, an internal 3A switching transistor takes the place of S1 in Fig.2, while diode D1 takes the place of S2. The output voltage is set by the ratio of R2 & R1, which feed a sample of the output voltage back to an internal comparator.

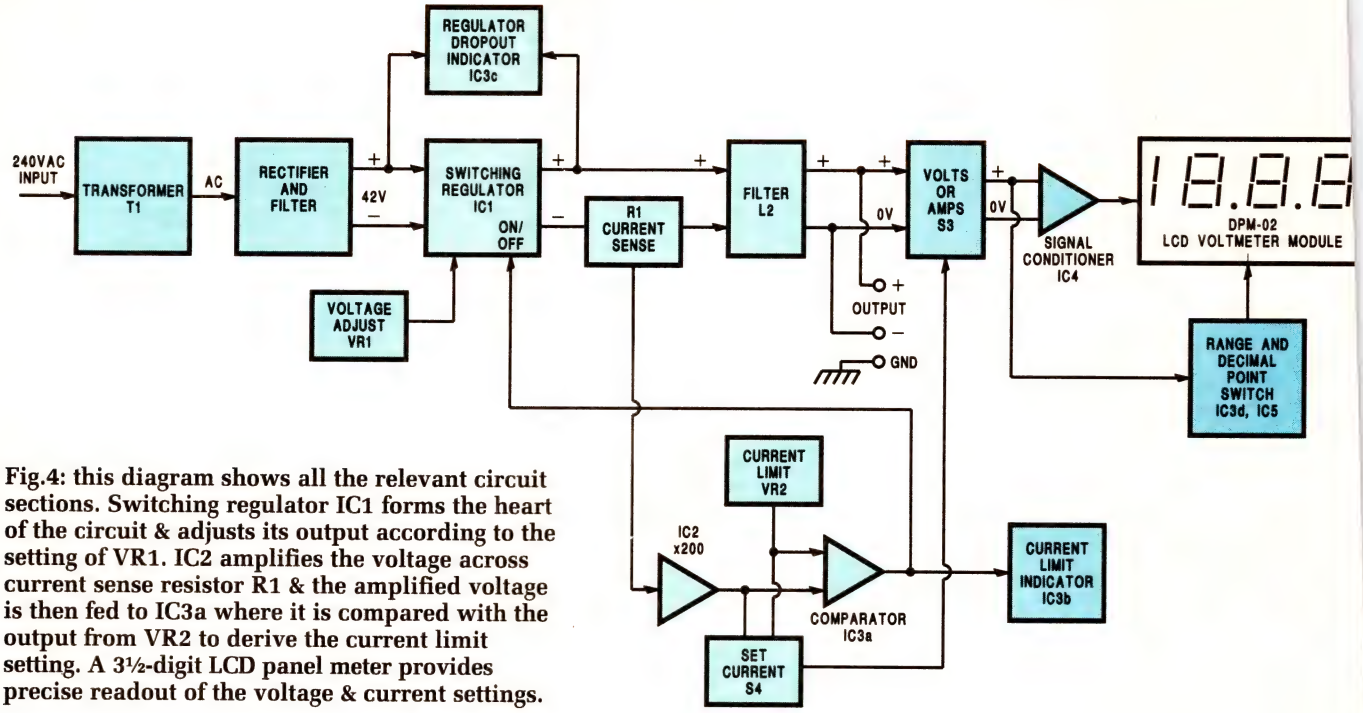


Fig.4: this diagram shows all the relevant circuit sections. Switching regulator IC1 forms the heart of the circuit & adjusts its output according to the setting of VR1. IC2 amplifies the voltage across current sense resistor R1 & the amplified voltage is then fed to IC3a where it is compared with the output from VR2 to derive the current limit setting. A 3½-digit LCD panel meter provides precise readout of the voltage & current settings.

at lower voltages. This is because of higher losses in the circuit due to the higher pulse currents involved at low voltage settings. The line regulation is less than 0.1% for a 10% change in mains voltage – see specifications panel.

Basic principle

The circuit is based on the National Semiconductor LM2576HVT high voltage adjustable switchmode voltage regulator. Fig.2 shows how a switching regulator operates.

In operation, S1 and S2 operate at high speed and are alternately closed and opened. These two switches control the current flowing in inductor L1. When S1 is closed and S2 is open, the current flows to the load via inductor L1 which stores up energy. When S1 subsequently opens and S2 closes, the energy stored in the inductor maintains the load current until S1 closes again.

The output voltage is set by adjusting the switch duty cycle and is equal to the input voltage multiplied by the ratio of S1's on time to its off time. Capacitor C1 is used to filter the resulting output voltage before it is applied to the load.

Fig.3 shows a complete voltage regulator based on the LM2576 IC. It is a 5-pin device which requires just five extra components to produce a basic working circuit. Its mode of operation is the same as that described in Fig.2 except that here a 3A switching transistor is used for S1, while an external diode (D1) is used for S2.

What happens in this case is that when the transistor is on, the current flows to the load via inductor L1 as before and D1 is reverse biased. When the transistor subsequently turns off, the input to the inductor swings negative (ie, below ground). D1 is now forward biased and so the current now flows via L1, the load and back through D1.

The output voltage is set by the ratio of R2 and R1, which form a voltage divider across the output (V_{out}). The sampled voltage from the divider is fed to pin 4 of the switcher IC and thence to an internal comparator where it is compared with a 1.23V reference. This sets V_{out} so that the voltage produced by the divider is the same as the reference voltage (ie, 1.23V).

Apart from the comparator and the switching transistor, the regulator IC also contains an oscillator, a reset circuit, an on/off circuit and a driver stage with thermal shutdown & current limiting circuitry. The incoming supply rail is applied to pin 1 of the IC and connects to the collector of the 3A switching transistor. It also supplies an internal regulator stage which then supplies power to the rest of the regulator circuit.

Basically, the LM2576 uses pulse width modulation (PWM) control to set the output voltage. If the output voltage rises above the preset level, the duty cycle from the driver stage decreases and throttles back the switching transistor to bring the output voltage back to the correct level. Conversely, if the output voltage falls, the duty cycle is increased and the switching transistor conducts for longer periods.

The internal oscillator operates at 52kHz ±10% and this sets the switching frequency. This frequency is well beyond the limit of audibility although, in practice, a faint ticking noise will occasionally be audible from the unit due to magnetostrictive effects in the cores of the external inductors.

One very useful feature of the LM2576 that we haven't yet mentioned is the On/Off control input at pin 5. As its name implies, this allows the regulator to be switched on or off using an external voltage signal. This feature is put to good use in this circuit to provide the adjustable current limiting feature, as we shall see later on.

Block diagram

Although the LM2576-ADJ forms the heart of the circuit, quite a few other parts are required to produce a practical working variable supply.

g.4 shows the full block diagram of e unit.

Power for the circuit comes from .e 240VAC mains. This feeds power ansformer T1 and its output is recti- ed and filtered to provide a 42V DC ıpply which is then fed to the input f the switching regulator (IC1). VR1 ets the output voltage from the regu- ator and essentially forms one half of ıe voltage divider shown in Fig.3.

IC3c monitors the input and output oltages from the regulator and lights LED when the difference between hem is less than 3.3V. This indicates hat the circuit is no longer regulating orrectly. Following the regulator, the urrent in the negative rail flows hrough the sensing resistor R1. The voltage across this resistor is then am- plified by IC2 and applied to compa- rator stage IC3a.

R1 has a value of just .005Ω, while IC2 operates with a gain of 200. This means that IC2's output voltage is numerically equivalent to the current (in amps) flowing through R1 (ie, IC2's output increases by 1V per amp). So, in addition to driving IC3a, IC2 is also used to drive the LCD digital voltmeter (via S4, S3 & IC4) to obtain current readings.

IC3a and potentiometer VR2 provide the current limiting feature. In operation, IC3a compares the voltage from IC2 with the voltage set by VR2. This voltage can be anywhere in the range from 0-4V, corresponding to current set limits of 0-4A. The circuit works as follows.

If IC2's output rises above the voltage set by VR2 (ie, the current through R1 rises above the set limit), IC3a's output goes high and turns off the switching regulator via the On/Off control. The current through R1 now falls until IC2's output falls below the voltage from VR2, at which point IC3a's output goes low and switches the regulator (IC1) back on again. The current now rises until the regulator is switched off again and so the cycle is repeated indefinitely.

By this means, IC3a switches the regulator on and off at a rapid rate to limit the current to the value set by VR2.

IC3a also drives comparator stage IC3b and this lights an indicator LED when ever current limiting takes place. Switch S4 selects between the outputs of IC2 and VR2, so that either the load current or the current limit setting is displayed on the LCD panel meter.

This makes it easy to set the current limit. All you have to do is press S4 and rotate VR2 (the Current Limit control) until the required value appears on the digital readout.

Immediately following R1 is a filter stage which is based mainly on inductor L2. This filter removes most of the ripple and high frequency noise from the positive and negative supply rails. The two supply rails are then applied to the load via S2.

Finally, the 3½-digit LCD panel meter is used to display either the output voltage, the output current or the current limit setting, depending on the positions of switches S3 and S4. The selected signal voltage is applied to the panel meter via signal conditioning amplifier IC4, which provides the required level shifting and attenuation.

For voltages up to about 18V, the display resolution is 10mV. It is then switched to a higher range with 100mV resolution to prevent over-range for output voltages above 20V. This task is performed using IC3d and IC5.

Specifications

Minimum no load output voltage	1.23V ±13mV
Maximum no load output voltage	40V
Output current	see graph
Current limit range	10mA to 4A
Current limit resolution	10mA
Line regulation	<0.1% for a 10% change in mains voltage
Voltmeter resolution	10mV from 1.23V to 16.5V (approx); 100mV from 16.5V to 40V
Current meter resolution	10mA
Meter accuracy	1% plus 2 digits
Load regulation	
no load to 3A @ 24V	1.5%
no load to 3A @ 12V	2%
no load to 3A @ 6V	2.8%
no load to 3A @ 3V	4.2%
Output ripple and noise	
3A @ 24V	5mV p-p
3A @ 12V	2mV p-p
3A @ 6V	1mV p-p
3A @ 3V	1mV p-p

Circuit details

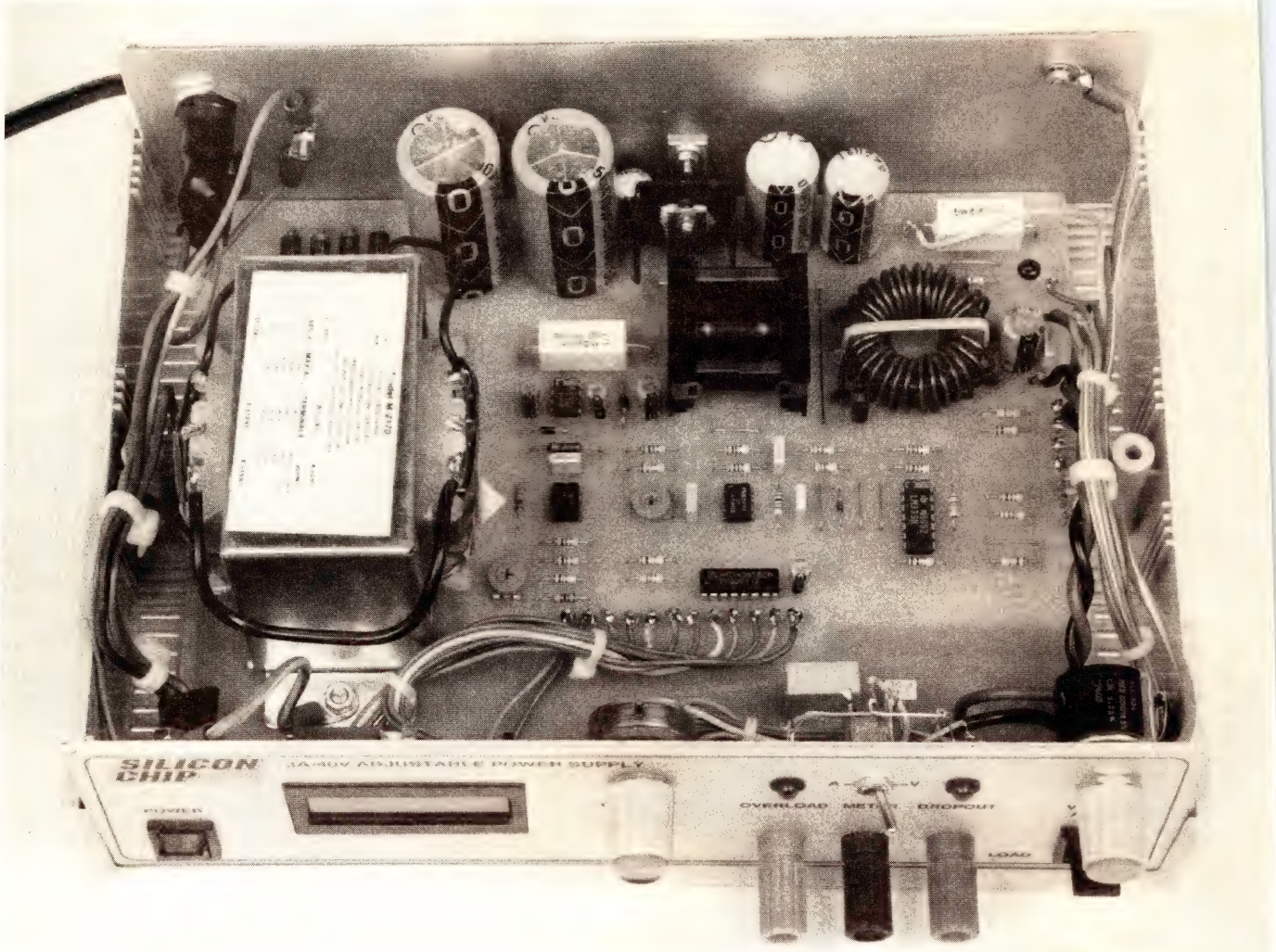
Refer now to Fig.5 for the full circuit details. It contains all the elements shown in the block diagram of Fig.4. We'll go through each of the major sections in turn.

Transformer T1 is supplied with mains power via fuse F1 and power switch S1. Its 30VAC secondary is full-wave rectified using diodes D1-D4 and filtered using two parallel 4700µF 50VW electrolytic capacitors. The resulting 42V DC supply is applied to the switching regulator (IC1).

Note the 100µF capacitor connected between pins 1 & 3 of IC1. This capacitor is necessary to prevent circuit instability and is mounted as close to the IC as possible.

D5, L1, the two parallel 1000µF capacitors and VR1 form the basic switchmode power supply block (see Fig.3). D5 is a Schottky diode which is rated at 10A and 60V. It has been specified in preference to a conventional fast recovery diode because of its low forward voltage drop. As a result, there is very little heat dissipation within the diode and this leads to increased efficiency.

The output from IC1 feeds directly into L1, a 300µH inductor. This is wound on a Philips ETD29 ferrite core assembly with a 1mm air-gap to prevent core saturation, as can occur when DC currents flow in ungapped core windings.



The 3A-40V Adjustable Power Supply is easy to build since most of the parts are mounted on a single PC board & the LCD panel meter is supplied ready made. No large heatsinks are required in the design because the switching regulator (IC1) dissipates very little power, even at low-voltage high-current settings.

VR1 and its associated 1.5kΩ resistor provide voltage feedback to pin 4 of IC1, to set the output level. When VR1's resistance is at 0Ω, the output from the regulator (pin 2) is equal to 1.23V. This output voltage increases as the resistance of the pot increases. The 680Ω 5W resistor connected across the regulator output discharges the two 1000µF capacitors to the required level when a lower output voltage is selected.

Filter circuit

Inductor L2 and its associated 100µF and 0.1µF capacitors make up the filter circuit shown in the block diagram (Fig.4). This LC network effectively attenuates the switching frequency ripple by a factor of 10.

In practice, L2 consists of two separate windings (L2a, L2b) on the same toroidal core. These two windings are phased so that the flux developed by L2a is cancelled by the flux developed by L2b. This type of winding arrangement provides what is known as DC compensation and is done to prevent core saturation.

As shown in Fig.5, L2a is used to decouple the positive supply rail, while L2b decouples the negative rail. The inductor thus effectively filters any common mode signals, while the 100µF and 0.1µF capacitors across the output attenuate any remaining spikes.

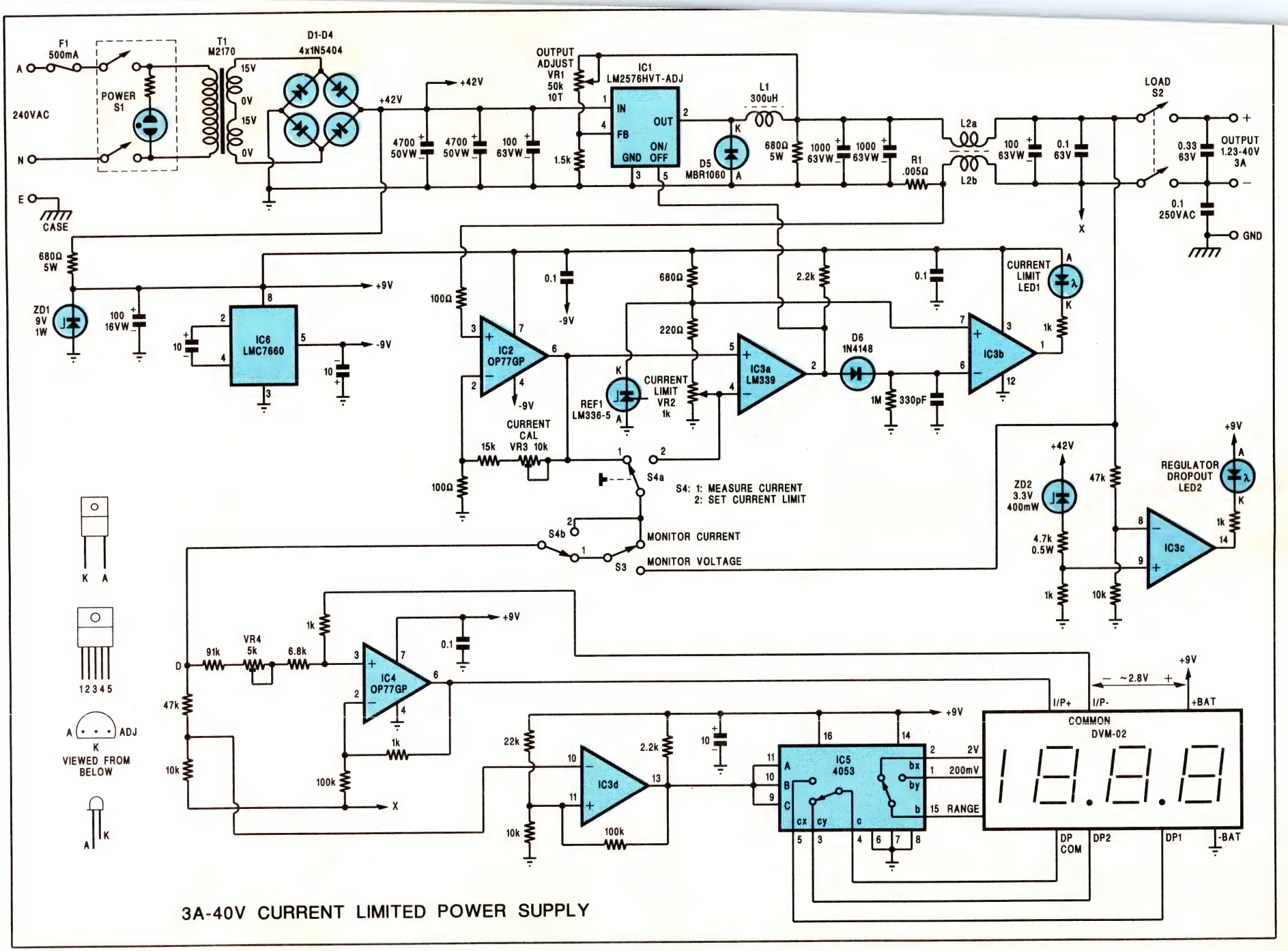
The resulting filtered voltage is then applied to the output terminals via load switch S2. Additional filtering is applied at this point using a 0.33µF capacitor across the terminals and a 0.1µF capacitor between the negative terminal and mains ground. Note that this 0.1µF capacitor must be rated at 250VAC to comply with safety standards.

Regulator dropout

Comparator IC3c and its associated parts form the regulator dropout indicator depicted on the block diagram. In this circuit, a sample of the output voltage is applied to pin 8 of IC3c and compared with a sample of the regulator input voltage at pin 9. Zener diode ZD2 provides an offset, so that IC3c only switches its output (pin 14) low when the voltage across the regulator drops below 3.3V.

In this situation, IC1 is no longer

Fig.5 (right): the main switching regulator circuit is based on IC1, L1 & D5, while IC2, IC3a & VR2 control the ON/OFF input of IC1 to provide the current limit feature. IC4 provides signal conditioning for the DVM-02 panel meter, with IC3d & IC5 providing automatic range switching.



3A-40V CURRENT LIMITED POWER SUPPLY

PARTS LIST

1 PC board, code 04202941, 222 x 160mm
1 front panel label, 250 x 75mm
1 plastic instrument case, 260 x 190 x 80mm
2 aluminium front & rear panels for above case
1 M-2170 30V 100VA mains transformer (Altronics)
1 LCD voltmeter module (Altronics Cat. Q-0560)
3 captive head binding posts (1 red, 1 black, 1 green)
1 2AG panel-mount fuseholder
1 500mA 2AG fuse
1 TO-220 heatsink, 26 x 30 x 15mm (Jaycar Cat. HH-8504)
1 SPDT mains rocker switch with neon indicator (S1)
1 DPDT paddle switch (S2) (DSE Cat. P-7693 or equiv.)
1 SPDT toggle switch (S3)
1 DPDT momentary pushbutton switch with common terminal at side (S4) (Altronics S-1394)
1 ETD29 transformer assembly with 3C85 core (Philips: 2 cores 4312 020 3750 2; 1 former 4322 021 3438 1; 2 clips 4322 021 3437 1)
1 RCC32.6/10.7, 2P90 ring core (Philips 4330 030 6035)
2 15mm diameter knobs
1 mains cord & plug
1 cord grip grommet
2 5mm LED bezels
26 PC stakes
5 self-tapping screws to mount PC board
2 4mm screws nuts & washers
4 3mm screws, nuts & star washers
1 3mm countersunk screw, nut & star washer (use a dress screw if the front panel is screen printed)
6 crimp lug eyelets for 3mm screw
2 solder lugs for 9mm thread
1 TO-220 insulating bush & washer
12 cable ties
1 50kΩ 10-turn pot (VR1)
1 1kΩ linear pot (VR2)
1 10kΩ horizontal trimpot (VR3)
1 5kΩ horizontal trimpot (VR4)

Wire & cable

1 2-metre length of 1.5mm enamelled copper wire
1 3.5-metre length of 0.8mm enamelled copper wire
1 60mm length of 0.4mm enamelled copper wire
1 200mm length of 0.8mm tinned copper wire
1 25mm length of 1.0mm enamelled wire (for use as a feeler gauge)
1 600mm length green/yellow mains wire
1 1.5-metre length of red hook-up wire
1 1.5-metre length of black hook-up wire
1 1.5-metre length of green hook-up wire
1 1.5-metre length of blue hook-up wire
1 200mm length of 3-way rainbow cable
1 200mm length of red 32 x 0.20mm hook-up wire
1 200mm length of black 32 x 0.20mm hook-up wire

Semiconductors

1 LM2576HVT-ADJ high voltage adjustable switchmode voltage regulator (IC1) (NSD)
2 OP77GP op amps (IC2,IC4)
1 LM339 quad comparator (IC3)
1 4053 CMOS switch (IC5)
1 LMC7660 switched capacitor voltage converter (IC6)
4 1N5404 3A 400V diodes (D1-D4)
1 MBR1060 Schottky diode (D5)
1 1N4148 signal diode (D6)
1 9V 1W zener diode (ZD1)
1 3.3V 400mW zener diode (ZD2)
1 LM336-5 5V reference (REF1)
2 5mm red LEDs (LED1,LED2)

Capacitors

2 4700µF 50VW electrolytic
2 1000µF 63VW electrolytic
2 100µF 63VW electrolytic
1 100µF 16VW electrolytic
3 10µF 16VW electrolytic
1 0.33µF 63VW MKT polyester
4 0.1µF 63VW MKT polyester
1 0.1µF 250VAC polyester
1 330pF MKT polyester

Resistors (0.25W, 1%)

1 1MΩ
2 100kΩ
1 91kΩ
2 47kΩ
1 22kΩ
1 15kΩ
3 10kΩ
1 6.8kΩ
1 4.7kΩ 0.5W
2 2.2kΩ
1 1.5kΩ
5 1kΩ
1 680Ω
2 680Ω 5W
1 220Ω
2 100Ω

Miscellaneous

Insulating tape, solder, heatshrink tubing, heatsink compound, 4.7Ω 5W resistor (for load testing).

regulating and IC3c lights LED 2 to provide a warning that the supply has dropped out of regulation.

Current limiting

The current sense resistor (R1) is wired into the negative supply rail before L2b and consists of a short length of 0.4mm enamelled copper wire. As explained previously, the voltage across it is multiplied by 200 using IC2, so that IC2's output delivers 1V per amp of load current.

In this application, IC2 must have low input offset voltage and input bias current specifications. This is necessary to ensure that IC2's output will be at 0V when no current is flowing through R1. The OP77GP used here typically has an input offset voltage of just 50µV and an input bias current of just 1.2nA.

Because its inputs operate at close to ground potential, IC2 must be powered from both positive and negative supply rails. The positive supply rail for IC2 (and for the remaining ICs) is derived from the output of the bridge rectifier via a 680Ω resistor and 9V zener diode ZD1. IC6, an LMC7660 switched capacitor voltage converter, generates the -9V rail for IC2.

In operation, IC6 first charges the 10µF capacitor between pins 2 & 4 to 9V. It then reverses the connections of the capacitor so that it can charge a second 10µF capacitor at pin 5 with negative polarity. This process is repeated continuously at a rate of about 10kHz so that the resulting output is a relatively smooth DC voltage.

Comparator stage IC3a monitors the

)utput voltage from IC2 and compares his with the voltage on its inverting nput, as set by current limit control /R2. This potentiometer and its asso-:iated 220Ω resistor form a voltage livider network which is connected across 5V reference REF1. In opera-:ion, VR2 sets the voltage on pin 4 of IC2 at between 0V and 4V, corresponding to current limit settings of 0-4A.

Because IC3a is an open collector device, its output at pin 2 is connected to the positive supply rail via a 2.2kΩ pull-up resistor. If the voltage at the output of IC2 is greater than that set by VR2, pin 2 of IC3a is pulled high by this resistor. This also pulls pin 5 of IC1 high and switches off the regulator to provide current limiting. At the same time, pin 6 of IC3b is pulled high via D6, and so pin 1 switches low and LED 1 lights to indicate current limiting.

When the current subsequently falls below the preset limit, pin 2 of IC3a switches low again and the regulator turns back on. Thus, IC3a switches the regulator on and off at a rapid rate to provide current limiting, as described previously. The 1MΩ resistor and 330pF capacitor at pin 6 of IC3b provide a small time delay so that LED 1 is powered continuously during current limiting.

Digital panel meter

IC4 forms the basis of the signal conditioning circuit. This op amp is wired in differential mode and operates with a gain of 0.01, as set by the resistor feedback networks on pins 2 and 3. Its output appears at pin 6 and is applied to the I/P+ input of the digital voltmeter (DVM-02).

The DVM-02 is a standard panel meter with differential inputs (I/P+ and I/P-) and requires a 9V power supply between its BAT + and BAT- terminals. Its I/P- input is fixed at 6.2V (ie, 2.8V below the positive supply) and this reference voltage is used to bias pin 3 of IC4 via a 1kΩ resistor. This bias produces an offset at the output of IC4 and ensures that the voltage fed to the digital voltmeter is within its operating range.

This signal conditioning is necessary because the DVM-02 cannot be used to directly measure voltages within 1V of either supply rail.

The voltage range of the DVM-02 is selected by bridging pads on the voltmeter PC board. In this case, only the 200mV and 2V ranges are used. The decimal point is selected in a similar manner (ie, by bridging DP1 or DP2 to DP COM).

In operation, switch S3 selects either the positive output rail or the output of IC2 to provide voltage or current measurement, respectively. The resulting voltage signal on the wiper of S4b is then applied to pin 3 of IC4 via VR4 and its associated series resistors. Alternatively, pressing S4 applies the voltage on the wiper of VR2, so that the current limit reading will be displayed on the DVM-02. This occurs regardless of the setting of S3.

In summary then, IC4 divides the voltage at point D by 100 and adds this to the 6.2V reference signal. Thus, if we are measuring an output voltage of 20V for example, IC4's output will be at 6.2 + 20/100 = 6.4V. This is 200mV greater than the reference voltage at I/P- which means that the meter will display 20.0 – assuming suitable range and decimal point switching.

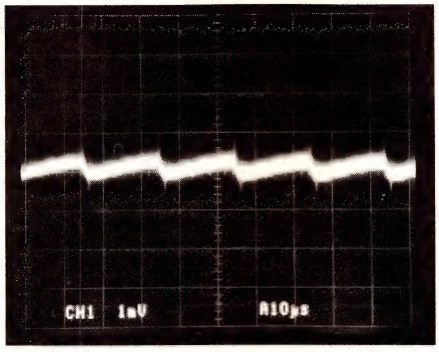


Fig.6: this scope photograph shows 100Hz ripple at the output terminals of the power supply when driving a 3A load at 12V.

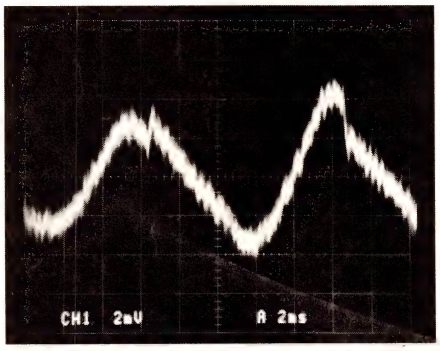


Fig.7: this is the 100Hz ripple for a 3A at 24V. Note the increase in ripple with the higher voltage.

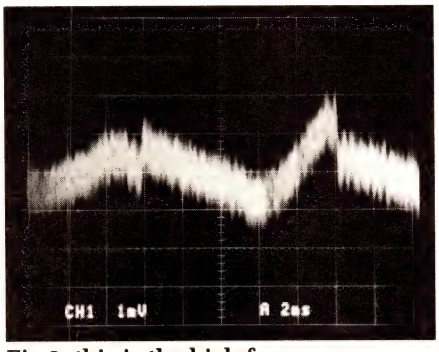


Fig.8: this is the high frequency switching noise as seen on a 100MHz oscilloscope using a 10:1 probe.

Range switching

IC3d and IC5 provide the range and decimal point switching, so that this operation is completely automatic. IC3d is wired as a Schmitt trigger and monitors the voltage between point D and the negative output rail (point X) via a voltage divider (47kΩ and 10kΩ).

IC3d's output drives the A, B and C inputs of IC5, a 3-pole 2-way CMOS analog switch. In this application, one switch pole (pole 'b') is used for range selection and another (pole 'c') for decimal point selection. The third switch pole is left unused.

When the voltage at D is less than 18V, IC3d's output is pulled high and pole 'b' connects to the 'by' position so that the 200mV range is selected. At the same time, pole 'c' connects to the 'cy' position so that decimal point DP2 is selected. This allows the display to read from 0.00 to 18.00 volts (approx.) with 10mV resolution.

However, if the voltage at point D rises above 18V, the output of IC3d switches low and so the A, B & C inputs of IC5 also go low. Pole 'b' now connects to the 'bx' position and pole 'c' to the 'cx' position, so that the 2V range and decimal point DP1 are now selected. The display can now read from 18.0 to 40.0 volts with 100mV resolution (note: the most significant digit is not used in this mode).

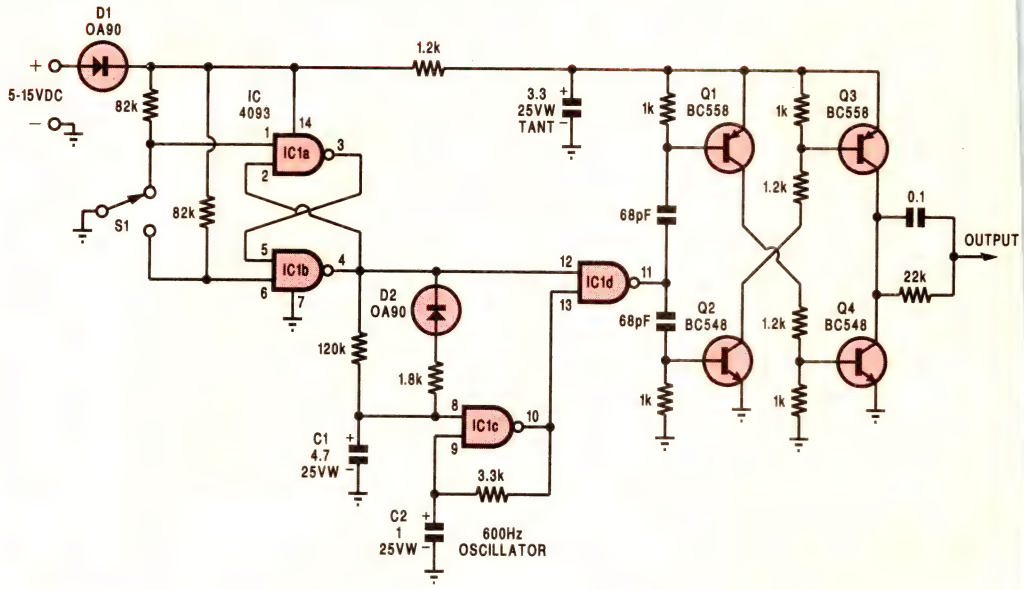
Because Schmitt trigger IC3d operates with about 3V of hysteresis (as set by the 100kΩ feedback resistor), the voltage at point D must now drop below about 15V before pin 13 switches high again to select the 200mV range on the DVM-02. The voltage at point D must then be increased above 18V again to select the 2V range. This small amount of hysteresis prevents display jitter at settings close to the range changeover point.

That completes the circuit description. Next month, we will describe the construction. **SC**

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

Amended pulser probe



This circuit was published in the July 1993 issue but incorporated a number of drafting errors. For completeness, we are re-publishing the circuit, together with a brief description of how it works.

Depending on how long pushbutton S1 is pressed, the circuit will generate a single pulse or pulse stream. IC1 is a 4093 quad NAND Schmitt trigger with IC1c connected as a free-running oscillator which is enabled whenever pin 8 is pulled low. This happens whenever S2 is pressed long enough to allow C1 to charge and thus take pin 8 high.

If S1 is pressed only briefly, the resulting low to high transition at pin 4 of IC1b is coupled though IC1d which sets its output at pin 11 high.

Pin 11 is capacitively coupled to an output stage comprising transistors Q1-Q4. If pin 11 goes high, Q2 and Q3 turn on while Q1 and Q4 turn off. Conversely, if pin 11 goes low, Q1 and Q4 turn on while Q2 and Q3 turn off.

Greg Freeman,
Nairne, SA.

Beta measurements with an analog multimeter

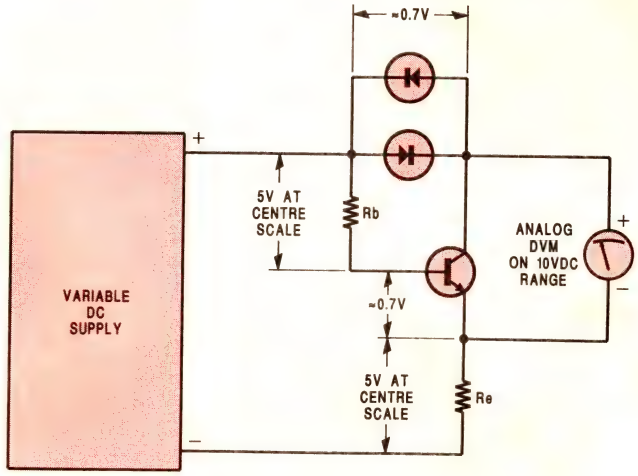
By using a simple setup, you can make a direct measurement of h_{FE} (Beta) for conventional and Darlington transistors at high currents. Most digital multimeters make Beta measurements at very low currents and do not give an indication of the gain at high currents. To do the test, you need a variable DC supply and an analog multimeter.

First, adjust the power supply output to read 10V DC on the meter, then connect the transistor to be tested. The emitter resistor R_E sets the maximum current drawn by the transistor while the base bias resistor R_B is used to set the base current.

For this method, we set the voltage from the power supply using the 10V range of the multimeter and then, without changing the range or mode, the Beta value is read directly off the "Ohms" scale.

Typically, the method involves selecting a suitable value for R_E to set the midscale current while R_B determines the base current at midscale which then determines the Beta multiplier.

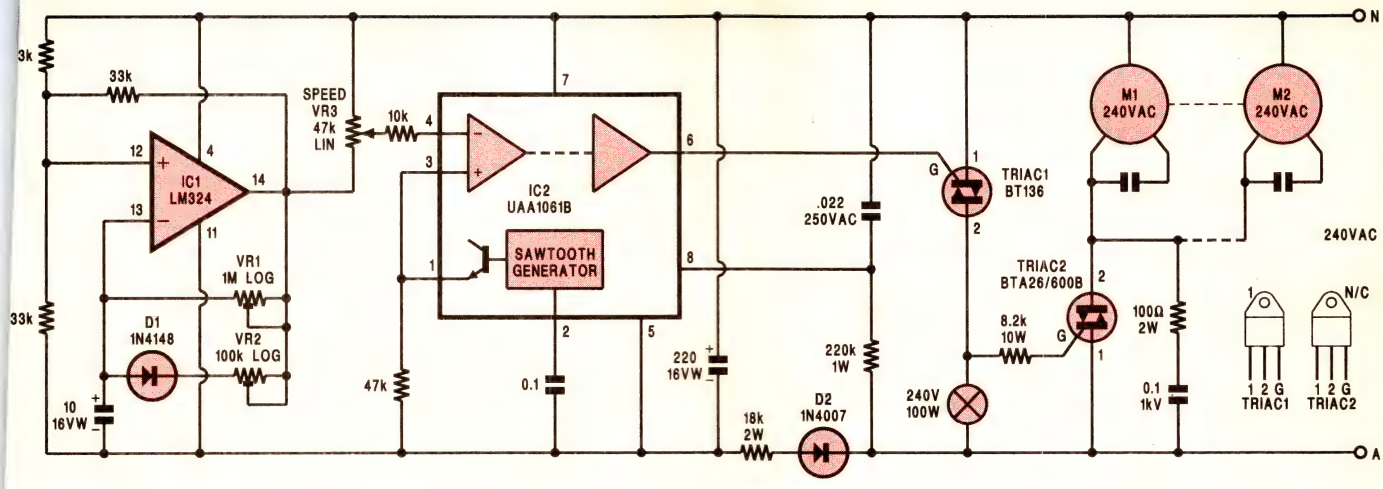
For example, to obtain 100mA at midscale (5V = 0.1A x R_E), R_E should be 50Ω. Most meters would have the "Ohms" scale reading 10 at centre scale, so if we want



Beta to read 1000 at centre scale, the desired multiplier is 100. To calculate R_B we use the formulas $R_B = 5V/i_B$ and $i_B = i_E/h_{FE} = 100mA/1000 = 0.1A/1000$. Therefore $R_B = 5/(0.1/1000) = 50k\Omega$.

The Ohms scale will indicate the h_{FE} directly between 100 to 10,000 with reasonable accuracy and can be used for matching transistors.

Victor Erdstein,
Highett, Vic. ($25)



Induction motor speed controller

Capacitor run or split-phase squirrel cage induction motors have come into common use because they have no centrifugal switch and have medium torque from zero to full speed. However, they cannot normally be run at low speeds unless a variable frequency supply is used. This circuit gets around that problem by using a burst fire method which also features zero voltage crossing triggering instead of phase angle firing of the Triac.

The circuit is used to control the speed of a set of five split phase motors for a light industry application. Due to the pulsing nature of the supplied power, the motors turn noisily but that is not a problem in comparison to the satisfaction of achieving quite good low speed control. The motors are 8-pole types with a normal operating speed of 725 RPM and this circuit is used to run them at about one tenth of that speed but only for 10 minutes at a time.

The heart of the circuit is IC2, a Motorola UAA1016B. Its features include an on-chip sawtooth generator for proportional control, plus even switching of positive and negative power cycles to keep the supply authorities happy (no DC line current).

The UAA1016B is designed to trigger Triacs which are switching high-current resistive loads like heater elements. In order to drive the highly inductive load of split-phase motors, the BT136 and the 100W lamp act to lock on gate drive to the main Triac (TRIAC2). This Triac also has a snubber network consisting of the 100Ω 2W resistor and .022μF capacitor to ensure reliable commutation.

The 0.1μF capacitor at pin 2 of IC2 sets the sawtooth proportional control frequency, while the speed control setting is determined by IC1. IC2 derives its DC supply from the mains via an 18kΩ 2W resistor and diode D2. IC2 then provides the DC rail to the LM324.

IC1 is connected as a Schmitt trigger oscillator with frequency and duty cycle set by VR1 and VR2 respectively. The pulse output at pin 14 is high for 0.5 seconds and low for 5 seconds. Unused inputs on the LM324 should be tied low.

Note that the **whole circuit floats at mains potential.** Do not touch any part of the circuit while power is applied and use a pot with a plastic shaft for VR3.

If you have trouble finding the UAA1016B, Worldwide Electronics in Perth stock them – phone (09) 367 6330.

G. Host,
Doubleview, WA. ($25)

Single-pot Wien bridge oscillator

This circuit is an interesting variation of the well-known Wien bridge oscillator in that it provides a frequency range of more than 15:1 using only a single potentiometer.

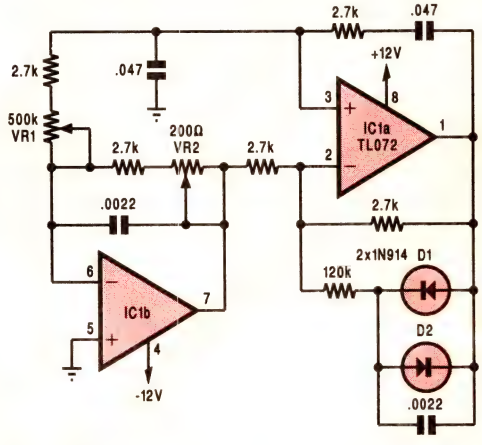
As presented, the oscillator covers the range from 82Hz to 1.25kHz. By contrast, a standard Wien bridge circuit requires a dual-ganged pot and would usually cover a range of only 10:1.

Op amps IC1a and IC1b form the oscillator circuit with a 2.7kΩ resistor and .047μF capacitor in series in the positive feedback loop from the output at pin 1 to pin 3 of IC1a. This op amp also has a negative feedback path to its pin 2, with diodes D1 and D2 acting the stabilise the amplitude of oscillation.

Op amp IC1b acts to feed an inverted portion of the signal at pin 3 to pin 2 and hence it controls the frequency of oscillation via potentiometer VR1 and the output amplitude via trimpot VR2.

Harmonic distortion is approximately 0.065% over the specified frequency range and the output signal is just over 3V RMS. The envelope stability is within ±0.4dB over the entire range.

Darren Yates, SILICON CHIP



The circuit is a variation of the Wien bridge configuration. VR1 sets the oscillator frequency, while VR2 sets the amplitude.

ALTRONIC COMPONENTS • Jet Express • AUSTRALIA WIDE

ALTRONIC COMPONENTS

Our Competitors Hate Us - Here's Why

One reason Altronics competitors are unhappy with us is because we deliver your order the very next day*. On top of this our fine products are often no dearer than the "hobby grade" components offered elsewhere.
Phone Free Call 008 999 007 for prompt and courteous attention every time.

Regards Jack O'Donnell

* Weekends and country areas please add 24 - 48 hours

Beat Triggered Strobe Kit

(AEM July '85) Designed by Australian Electronics Monthly. Flashes in time to your music. Will also work as normal strobe. Exclusively customised by Altronics into our H 0480 Instrument Case, making construction a breeze and improving stability, safety and overall appearance. Includes silk screened panel. Two tube option available which boosts lighting output.

K 5790 Strobe Kit Normally $79.95

This Month Only $75

K 5795 Two Tube Option $16.50

High Energy Ignition System Kit

Keep Your Car In Top Tune. Save Money on Petrol, Plugs & Points & Increase Performance!

(SC May '88) This "state of the art" electronic ignition system uses the same semi-conductors as found in modern motor car ignitions. Extends the life of plugs and points. Increases power and improves fuel economy. Compatible for 4, 6 and 8 cylinder engines. Uses dedicated Motorola IC. Install one into your car and start saving $$$ from the very first day. Comes with full explanation of your vehicle's ignition system.

K 4015 $58.50

Altronics Gift Vouchers

A Great Birthday gift etc for that budding genius son or daughter of yours. Redeemable any time throughout 1994.

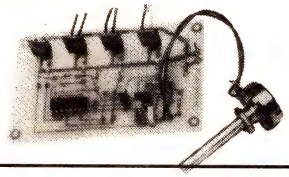
12 or 24V Light Chaser Kit

Impress Your Friends with a Custom Lighting Display! Sorry Not Available from ALTRONIC Re-Sellers

This is a nifty circuit which will drive 4 channels in sequence. Suitable for 12 or 24 volts up to 35 watts each channel. Includes case (not illustrated).

K 5810 Normally $39.95

This Month Only $20.00



New High Performance Series Mosfets

This new range is a direct replacement for the now discontinued Hitachi mosfet range, making them ideal for amplifiers etc. Call Altronics for full specifications.

Manufactured in the UK to Military Specifications!

Specifications Z 1450-Z 1456:
Drain Source Voltage: 160V
Gate Source Voltage: .....±14V
Drain Current:.....8A
Body Drain Diode:.....8A
Total Body Dissipation: ...125W

Specifications Z 1470-Z 1476:
Drain Source Voltage: 160V
Gate Source Voltage: .....±14V
Drain Current:.....16A
Body Drain Diode:.....16A
Total Body Dissipation: ...250W

NEW

Z 1450	2SK134	$16.95
Z 1452	2SJ49	$17.75
Z 1454	2SK176	$19.50
Z 1456	2SJ56	$19.95
Z 1470	2SK135*	$28.85
Z 1472	2SJ50*	$29.25
Z 1474	2SK176*	$32.25
Z 1476	2SJ56*	$32.95

* N.B. These models are now high current ratings

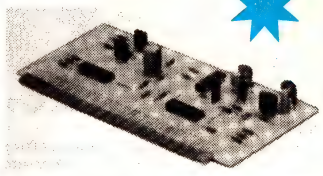
Direct Replacements for the Hard to find 2SK & 2SJ Series!

Twin Range LED Tacho Kit

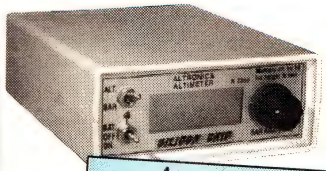
Replace that Old Analogue tachometer! Sorry Not Available from ALTRONIC Re-Sellers

Featuring 20 LEDS in a single line to give a simple and effective read-out at a glance. A great kit to replace those old analogue tachometer! Suitable for 2,3,4,6 and 8 cylinder cars. Stocks are limited.

K 4324 Now Only $20



Digital Altimeter Kit



Accurate to Better than 3.5%. A must for Hang-Gliders Ultralights etc. Hurry - Stocks are Limited!

This compact digital altimeter can display altitude up to 19,990 feet with 10 feet resolution. Accurate to better than 3.5 percent. A must for hang-gliders, ultralights etc. Operates from a single 9V battery.

K 2580 Normally $299.00

This Month Only $229.00

Why Pay up to $500 for a Commercial Unit?

DC-DC Converter for Car Amplifiers Kit

Fantastic for our Amp Module Kits!

Most amplifier modules requires a much higher voltage than just 12 volts to operate in a car. Enter this kit. This kits input is 12 volts but its output is +/- 35V to 50V at 1.15 amps. This can be used to run 2 x 50W modules or 1 x 100W module. Great for building sub woofers etc.

K 4100 Normally $139.95, **This Month Only $119.00**

Video Fader Kit

Here is a fantastic kit which allows you to create great fades and wipes when editing on your VCR. It can wipe left and right as well as fade to black or white. Complete with professional screen printed front panel and manual controls for fades and wipes. Simply plugs in between the two video machines when recording from one to the other.

K 5870

$32.95

NEW

Makes Professional Fades & Wipes When Editing Videos

Auto Power Switch Master/Slave Kit

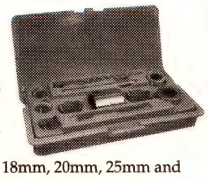
Simply plug in your amplifier the CD, tuner, tape deck etc. and each time you turn on the amp all the others automatically power up. Also great for computers and printers or videos and TV

K 6070 $59.95

Can be Used to Turn on Your Hi-Fi Components with Just One Switch!

PHONE ORDER - FREECALL 1800 999 007

Hole Punch Set



uts neat and recise holes in etal up to 6mm (16 auge). Set of 5 unches and apered reamer. unch sizes nclude: 16mm, 18mm, 20mm, 25mm and 0mm, Ideal for enthusiasts who want a rofessional finish to their metal housed rojects etc.

T 2360 Normally $97.00

This Month Only $69.00

Door Alarms

Amazing Price! Only While Stocks Last!

With this simple device you can monitor any door in your house. This two piece alarm consists of a control box and a magnet. The magnet simply mounts onto the door frame while the control box is mounted onto the door, so that they are opposite when the door is closed. Easy to use on/off switch. Built-in beeping buzzer sounds when tripped. Requires 9V battery.

S 5315 Normally $19.95

This Month Only $6.95

300 Watt Inverter

Fantastic for Power Supplies etc!

This nifty inverter converts 12 Volts DC to 240 Volts AC. Includes an on/off switch and a light & heavy load switch with metered output. Works well with most electrical equipment.

M 8120 NORMALLY $249.00

This Month Only $229.00

Whopper Speaker Cable

High quality, heavy duty and low loss cable for superior hi-fi sound.

Fantastic for Cars, Boats, Homes etc.

W 0130 **$2.95** per metre,

or **$99** per 50m roll

3mm De-Solder Braid

Buy in Bulk & Save!

Quality American manufacture. Ideal size for most general purpose electronic use.

T 1234 Normally $4.00 ea

This Month Only $3.50 ea

or 5 Rolls and Up $3 ea

Universal Metal Box

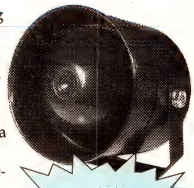
Fantastic for Power Supplies etc!

Constructed from 1mm aluminium for the base and 1mm mild steel for the lid, this chassis is ideal for power supplies. It has an enormous amount of ventilation, making it ideal for high current power supplies etc. Even the base is ventilated to allow for natural cooling. The lid is black powder coated, whilst the base is natural aluminium. Dimension: 180w x 100h x 180d mm

H 0430 Normally $29.95

This Month Only $22.50

High Power Sirens



Massive 120dB Output!

Features strong and durable construction, making it ideal for car, boat or home installation. Includes a handy bracket for wall mounting etc. Extremely loud 120dB output. Requires 12V DC at 300mA. Dimensions 100mm Ø by 125mm Long.

S 6130 **$30.95**

Amazing AA NiCad Battery Bargain

Premium grade quality. AA size only. 500mA capacity. Great for those battery hungry toys, cassette players etc.

Buy in Bulk & Save Ideal for Those Battery Hungry Christmas Toys!

S 5020 AA Size Normally $3.95

This Month Only $2.95 ea

or $2.50 ea 10 up

100mm Super Carbon Fibre Speakers

Fantastic for Cars, Boats, Homes etc.

These amazing little speakers will impress you and your friends. Carbon fibre is a new high tech material from which these speaker cones are made. Complimented with Barium Ferrite Magnets the results are simply amazing. 16 ohm voice coils make these units ideal for multi-speaker installations a breeze. Weather-proof design means they are fantastic for cars, boats, homes etc.

C 0643 Normally $39.95

This Month Only $25.00 ea, or $40.00 Pair

Palm Grip Series Flat Nose Pliers

Serrated jaws. Suitable for holding and griping. Spring loaded insulated handles.

T 2710 Normally $9.95

This Month Only $6.95

Nibbling Tool

Give Your Projects that Professional Look!

For steel, plastic and aluminium. Capacity: 1mm for steel, and 1.6mm for aluminium, Ideal for the hobbyist and technician who want a professional appearance for their projects.

T 2355 Normally $21.95

This Month Only $18.95

Palm Grip Series Needle Nose Pliers

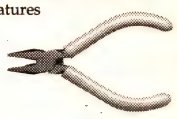
Serrated jaws. Suitable for holding and griping. Spring loaded insulated handles.

T 2720 Normally $9.95

This Month Only $6.95

Mini Ball-Nose Pliers

Strong serrated jaws. Suitable for holding and griping. Also features flush cutters for cutting larger components. Spring loaded insulated handles.



T 2797 Normally $8.95

This Month Only $6.95

4 Channel Economy Mixer

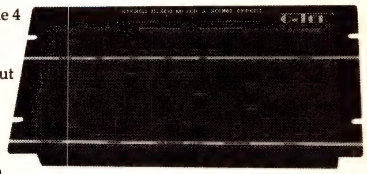
This compact mixer has inputs suitable for microphone, record players, camera audio, CD, Tape, and Tuner etc. Ideal for amateur cinematographers who would like to add their own background music and/or voice overs. Includes inputs for microphone, phono (with magnetic or ceramic cartridge), camera audio and an auxiliary (CD, tape, tuner etc). Features headphone output and master volume control. Requires M 9005 9V DC plug pack.

A 2520 Normally $119.00

This Month Only $99

Stereo Disco & Sound Effect Mixer

Mixes 5 Channels in Stereo! Includes Special Electronic Sound Effects



Features: • 5 channels with 8 inputs (first 3 channels are switchable between 2 inputs • Input facilities include: DJ mic, mic, phono 1, phono 2, line 1, line 2, line 3, line 4 • All inputs other than microphones are stereo • Treble, bass and master volume controls allows you to fine tune the output • Cross fader control between phono 1 and 2 • Cue monitor select and level • Twin LED master VU displays • Special effects circuit simulates, bombing, laser, ambulance, shooting, siren, machine gun, telephone and storm. Ideal for DJ's, bands etc.

A 2530 Normally $219.00, **This Month Only $199**

CD Cleaner

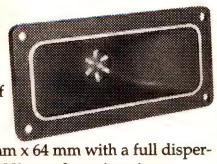
We are clearing out our CD Cleaners. These cleaners use the correct motion for removing small surface scratches and general dirt and grime.

A 9220 NORMALLY $17.95

This Month Only $7.95

Piezo Tweeters

We are clearing a large quantity of piezo tweeters out at half price. These rectangular horns 144.8mm x 64 mm with a full dispersion angle of 90° are a bargain price. Frequency response 3 K to 40 Khz. Sensitivity 110 Db @ 2.8 V. Only while stocks last.



C 6120 Normally $19.50

This Month Only $10.00

6.5" & 8" Carbon Fibre Woofers

A lightweight cone helps to produce a more accurate reproduction. These drivers use a kapton voice coil which dissipates heat faster than conventual speakers.

6.5" C 3034 Specifications

Rated Power:....70W Max
Impedance:.....8 Ohm
Res. Freq.:.....65Hz
Sensitivity:.....97dB/W (0.5m)

C 3034 6.5" Normally $82.55

This Month Only $59.95

8" C 3036 Specifications

Rated Power:....100W Max
Impedance:.....8 Ohm
Res. Freq.:.....35Hz
Sensitivity:.....93dB/W (0.5m)

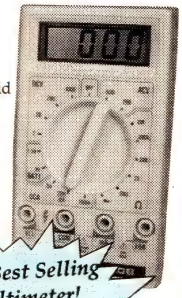
C 3036 8" Normally $124.95

This Month Only $109.95

ALTRONIC COMPONENTS

ALTRONIC COMPONENTS

17 Range Economy 3.5 Digit Digital Multimeter



Our most popular multimeter. With quality and features you would expect only on expensive meters the Q 1056 represents excellent value for money.

Specifications:

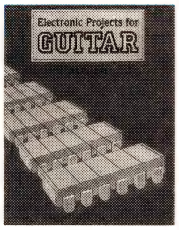
DC Voltage Ranges: 2V, 20V, 200V, 2000V
AC Voltage Ranges: 200V, 500V
DC Current Ranges: 200mA, 20mA, 2mA, 10A
Resistance Ranges: .....200 Ohm, 2k Ohm, 20k Ohm, 200k Ohm, 2M Ohm
Battery Test Ranges:.....1.5V, 9V Loaded
Battery Test Current:.....1.5V 100mA, 9V 6mA

Q 1056 Normally $59.95

This Month Only $39.95

Our Best Selling Multimeter! Save a Massive $20

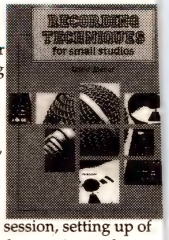
Electronic Projects for Guitars



By RA Penfold. Make your own guitar effect pedals from commonly available component. Ideal for both those who are experienced and beginners alike. It's a collection of 16 guitar and general purpose effect units. Each project has an introduction, a circuit diagram and complete instructions.

B 2230 $21.50

Recording Techniques for Small Studios

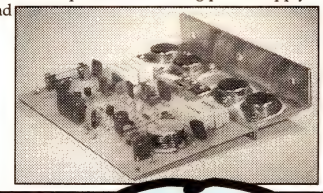


This book is ideal for musicians, recording engineers and enthusiasts alike. It covers recording techniques for vocal, drums, guitars, keyboard, using MIDI and multi-track. As well as planning the session, setting up of microphones, musical arranging and a whole lot more!

B 2226 $23.95

Amplifier Module Kit Clearance

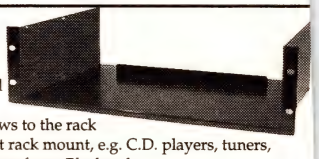
We have a quantity of discontinued amplifier modules which we need to clear to make way for new stock. Both modules come complete with all components (excluding power supply) to build high power amps. Includes heatsink and heatsink bracket. Not available from Altronic Dealers.



K 5140 100W into 4 ohms, NORMALLY $69.00, **This Month $50.00**

K 5150 150W into 4 ohms NORMALLY $99.00, **This Month $69.00**

Rack Shelves



In some cases heavy equipment, eg. large amplifiers, tend to sag at the rear when installed in racks. With the addition of one of these shelves this tendency is eliminated. Simply screws to the rack frame. Also suitable for equipment that does not rack mount, e.g. C.D. players, tuners, videos etc. Overall depth 255mm. 3 sizes to choose from. Black only.

H 5352 2 Unit **$49.95** **H 5353** 3 Unit **$49.95** **H 5354** 4 Unit **$55.95**

Powerhouse 600W Inverter

Includes Heavy Duty Battery Leads! Not Available from Altronic Re-Sellers

We have a small quantity of now superseded models. These Power Inverters are rated at up to 600 watts with no surge capability. They will provide all your power requirements (up to 600W max) from a heavy duty 12 battery. The Powerhouse has been designed not only for rugged operation but for ease of construction. Suitable for use in camping, boating, fishing, mining, farming, remote settlements etc. Fully built and tested.

K 6774 Normally $699.00

This Month Only $550

Hurry - Stock is Limited!

Micron Series II Soldering Station

The *MICRON* Series 2 soldering station employs electronic switch mode circuitry in lieu of a mains transformer. Excellent for all general purpose and production soldering.

Features:

- High insulation ceramic heating element in both rapid heat-up and instant recovery
- Heater insulation of over 100MΩ
- A zero voltage circuit ensures no high voltage spikes or magnetic field are present at the tip to damage sensitive components
- Continuous temperature adjustable from 250° to 430° C (480° to 800° F) • Grounded power cord

Selecting the desired operating temperature is as simple as turning a knob.

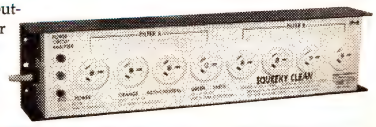
Simply choose the operating temperature required for the job and adjust the control to the appropriate setting. With its huge temperature range from 250° to 430° C this iron is suitable for most applications, from delicate double sided PCB's through to typical day to day jobs.

T 2443 $129.95

Just Arrived! A Soldering Station for Under $130

Squeeky Clean Mains Filters

Save your precious and expensive computer hardware and hi-fi etc from the power surges, spikes, and lightning. Includes 2 filters and 8 outlets.



P 8170 Only $299

ALTRONICS
174 Roe St. Perth W.A. 6000
Phone (09) 328 1599, **Fax** (09) 328 3487
MAIL ORDERS C/- P.O. Box 8350
Perth Business Centre, W.A. 6849

STANDARD DELIVERY & PACKING CHARGE $3.50 to 500gms, $5.50 500gms -1 kg, $8 1kg-5kg **AUSTRALIA WIDE**-We process your order the day received and despatch via. Australia Post. Allow approx 9 days from day you post order to when you receive goods.

OVERNIGHT JETSERVICE Up to 3kg is $10.00, 3kg to 5kg is $23.00—We try to process your order the day received and despatch via. **Overnight Jetservice Courier** for delivery next day Country areas please allow additional 24-48 hours.

HEAVY HEAVY SERVICE-All orders of 10kgs or more must travel Express Road—Please allow 7 days for delivery. $12.00 to 10kgs. $15.00 over 10kgs.

INSURANCE-As with virtually every other Australian supplier, we send goods at consignee's risk. Should you require comprehensive insurance cover against loss or damage please add $1.00 per $100 of order value (minimum charge $1). When phone ordering please request "Insurance".

TOLL FREE PHONE ORDER-Bankcard, Visa, Mastercard Holders can phone order toll free up to 4pm Eastern Standard Time. Remember with our Overnight Jetservice we deliver next day.

ALTRONICS RESELLERS Chances are there is an Altronic Reseller right near you—check this list or phone us for details of the nearest dealer. Blue Ribbon Dealers are highlighted with a ● These dealers generally carry a comprehensive range of Altronic products and kits or will order any required item for you.

WA - COUNTRY

ALBANY	BP Electronics ●	(098) 412681
	Micro Electronics	(098) 412077
BUNBURY	Micro Electronics	(097) 216222
ESPERANCE	Esperance Communications	(090) 713344
MANDURAH	Forum Electronics	(09) 5813466
PORT HEDLAND	Ivan Tomek Electronics	(091) 732531
ROCKINGHAM	TV Joe's	(09) 5271806

NT

ALICE SPRINGS	Farmer Electronics	(089) 522388
DARWIN	Ventronics	(089) 853 622

VIC - CITY

	All Electronic Comp	(03) 6623506
	TECS ●	(03) 6706474
BORONIA	Ray Cross Electronics ●	(03) 7622422
CHELTENHAM	Talking Electronics	(03) 5842386
CROYDON	Truscott Electronics ●	(03) 7233860
FOOTSCRAY	G.B. Telespares	(03) 3266035
PRESTON	Preston Electronics ●	(03) 4840191

COUNTRY

BAIRNSDALE	LH & LM Crawford	(051) 525677
BALLARAT	Ballarat Electronics	(053) 311947
BENDIGO	Sumner Electronics	(054) 431977
MILDURA	Pullman Auto	(050) 232882
	Truscott Electronics ●	(050) 238138
SHEPPARTON	Andrew Guyatt Elect.	(058) 219497
WARRNAMBOOL	Koroit Electronics	(055) 627 417

QLD - CITY

	Delsound PL●	(07) 8396155
NEWSTEAD	E.C.Q.	(07) 2541153
WEST END	B.A.S. Audiotronics	(07) 8447566
WOODRIDGE	David Hall Elect.●	(07) 8082777

COUNTRY

GLADSTONE	Gladstone Elect. Services	(079) 724459
	Electronic Enterprises	(079) 726660
MAROOCHYDORE	Mals Electronics ●	(074) 436119
TOWNSVILLE	Super Solex ●	(077) 724466

SA - CITY

	Force Electronics ●	(08) 2125505
BRIGHTON	Force Electronics ●	(08) 3770512
FINDON	Force Electronics ●	(08) 3471188
HOLDEN HILL	Force Electronics ●	(08) 2617088
LONSDALE	Force Electronics ●	(08) 3260901
SALISBURY	Force Electronics ●	(08) 2830755

COUNTRY

WHYALLA	Eyre Electronics	(086) 454764

TAS

HOBART	George Harvey ●	(002) 342233
LAUNCESTON	George Harvey ●	(003) 316533

NSW - CITY

	A-One Electronics	(02) 2674819
	David Reid Elect. ●	(02) 2671385
SMITHFIELD	Chantronics	(02) 6097218

COUNTRY

COFFS HARBOUR	Coffs Habour Elect.	(066) 525684
NEWCASTLE	Novocastrian Elect.Supplies	(049) 621358
WARNERS BAY	Vilec Distributors	(049) 566792
WINDSOR	M & E Elect. and Comm.	(045) 775935
WOLLONGONG	Newtek Electronics ●	(042) 271620
	Vimcom Electronics	(042) 284400
WOY WOY	Alphatran Electronics	(043) 434919

PHONE ORDER - FREECALL 1800 999 007

SILICON CHIP

ORDER FORM

BACK ISSUES

MONTH	YEAR	MONTH	YEAR	PRICE EACH (includes p&p)	TOTAL
				Australia (by return mail) $A7 NZ & PNG (airmail) $A7 Overseas (airmail) $A10	$A

BINDERS

Please send me _____ SILICON CHIP binder(s) at $A14.95 each (incl. postage within Australia). NZ & PNG orders please add $A5.00 each for postage. Not available elsewhere. **$A**

SUBSCRIPTIONS

❑ New subscription – month to start_____

❑ Renewal – Sub. No._____ ❑ Gift subscription ☞

RATES (please tick one)	2 years (24 issues)	1 year (12 issues)
Australia	❑ $A90	❑ $A49
Australia with binder(s)*	❑ $A114	❑ $A61
NZ & PNG (airmail)	❑ $A135	❑ $A72
Overseas surface mail	❑ $A135	❑ $A72
Overseas airmail	❑ $A240	❑ $A120

*1 binder with 1-year subscription; 2 binders with 2-year subscription

GIFT SUBSCRIPTION DETAILS

Month to start_____

Message_____

_____

_____

Gift for:
Name_____
(PLEASE PRINT)

Address_____

_____

State_____Postcode_____

YOUR DETAILS

Your Name_____
(PLEASE PRINT)

Address_____

_____Postcode_____

Daytime Phone No._____ **Total Price $A** _____

❑ Cheque/Money Order ❑ Bankcard ❑ Visa Card ❑ Master Card

Card No. | | | | | | | | | | | | | | | | |

Signature

_____

Card expiry date_____/_____

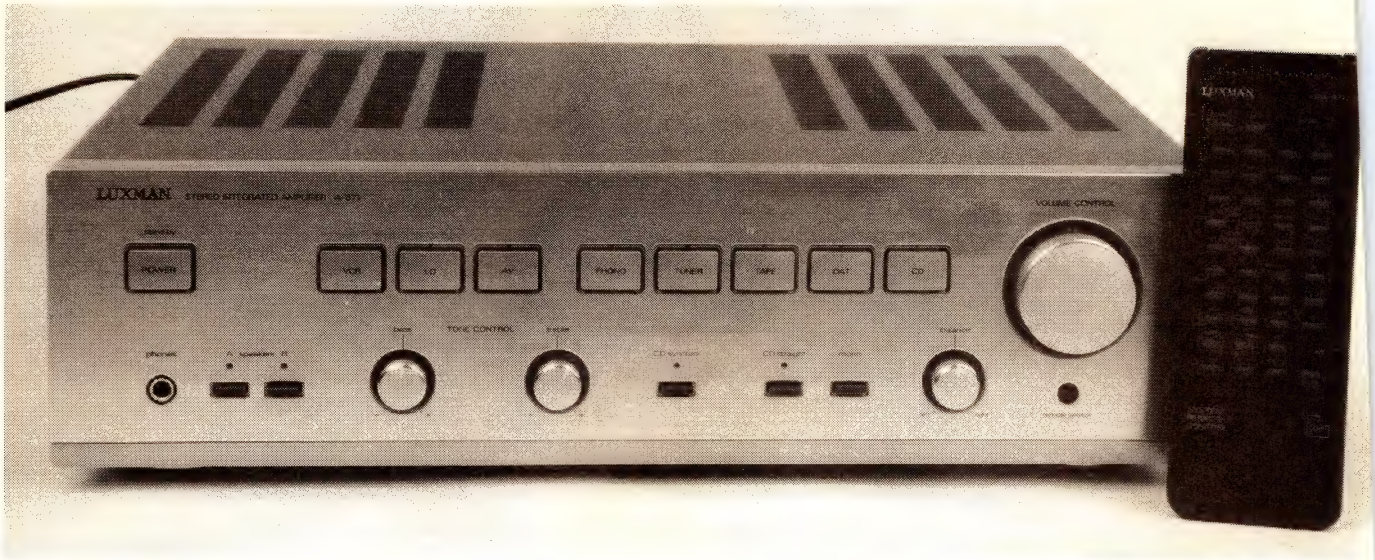
Phone (02) 979 5644
9am-5pm Mon-Fri.
Please have your credit card details ready

OR

Fax (02) 979 6503
Fax the coupon with your credit card details
24 hours 7 days a week

OR

Mail coupon to:
Freepost 25
Silicon Chip Publications
PO Box 139, Collaroy 2097
No postage stamp required in Australia



Luxman A-371 amplifier & D-351 CD player

Luxman is a hifi brand which will be well-known to many older enthusiasts but perhaps not so well known to younger readers. Produced by one of the smaller Japanese hifi companies, Luxman has a reputation for high quality equipment with no unnecessary frills or gimmicks.

We recently had the chance to review two models from Luxman's recently released range, the A-371 stereo amplifier and the D-351 compact disc player. Now while these units have a wealth of features, their front panels are certainly clean and well laid out and not at all daunting to the user. In addition, they have one other feature which will be most attractive to many users – front panels in champagne finish. These are a welcome alternative to black finished front panels.

Talking about the A-371 amplifier first, this is an attractive unit which at the same time is quite subdued in its styling. It measures 437mm wide, 125mm high and 363mm deep, including knobs and rear projections. It weighs 9.5kg.

The control layout is fairly simple with a large volume control knob on the right hand side and then three small knobs for bass, treble and balance controls. There are eight large pushbuttons, for power and source selection: VCR, LD (laser disc player), AV (audio visual source), phono, tuner, tape, DAT and CD. As well, there are three smaller pushbuttons for selection of two pairs of loudspeakers, mono mode and two modes called "CD synchro" and "CD straight". We'll talk about these a little later. All source selection and control of the volume level can be done via the infrared remote control, a feature which is becoming standard with a lot of hifi equipment these days.

On the rear panel, there is the usual plethora of RCA phono sockets, including those for video input and output signals. There are eight shrouded binding post terminals for connection of loudspeakers and a pair of jack sockets marked "bus line" which enables other Luxman equipment to be controlled via the amplifier's remote control handpiece.

Inside, the amplifier is packed with a surprising amount of circuitry. Apart from that which you would expect in a normal amplifier in the way of preamp, tone control and power amplifier boards, there are boards associated with the pushbutton source selection and the infrared remote control, all of which is overseen by a custom microprocessor.

There are two power transformers, one small and one quite large. We assume that the small one is energised all the time so that the amplifier's remote control circuitry can respond to the remote handpiece or front panel power button and "wake up" the main power supply when required.

The amplifier is double insulated and comes with a twin-core mains flex. The internal wiring does appear to conform to double insulation standards but we do regard it as dangerous

one aspect. If the cover of the amifier (or the matching CD player) is moved, the 240VAC wiring connections are completely unshrouded and would be easy to touch them inadertently. Granted, the rear of the chas has a warning notice saying "Cauon: risk of electric shock. Do not pen" but we would like to see those 40VAC connections made much safer or the person who will inevitably pen the case at some stage in its life.

To provide the remote volume control facility, the volume control is powered by a small DC motor via a clutch which lets the user adjust the control manually if desired.

For the purists, the A-371 has its 'CD straight" feature. By pushing this button, most of the switching, tone control and other ancillary circuitry is bypassed by the input signals from the CD player and they go straight from the volume control to the power amplifier circuitry.

The interior of the A-371 stereo amplifier has quite a few PC boards, with additional boards being required for the front-panel pushbutton controls & the video switching inputs & outputs on the rear panel. Note the generously proportioned power transformer which is fitted with a copper strap.

D-351 CD player

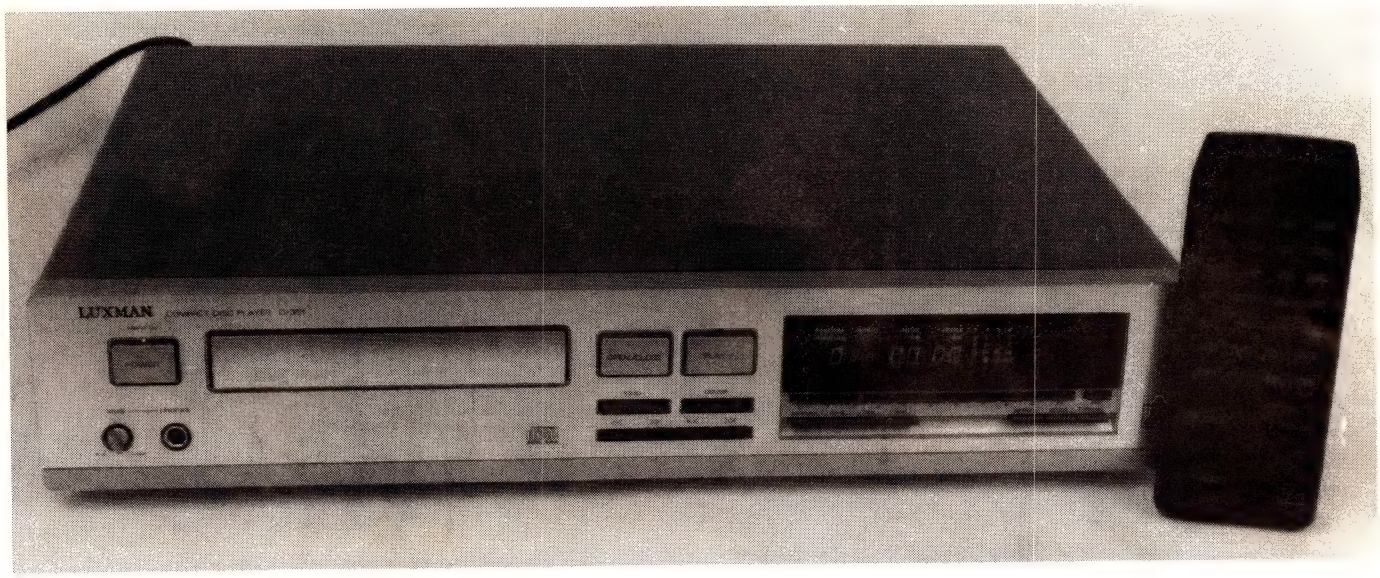
The other piece of equipment in this review is the Luxman D-351 CD player which has an overall width and styling to match the A-371 amplifier. Note however that it could be unwise to stack equipment on top of the A-371 amplifier as this would possibly cause problems with ventilation in the amplifier and it might also cause hum induction into the CD player. If the equipment is to be stacked, the amplifier should at the top, for best ventilation.

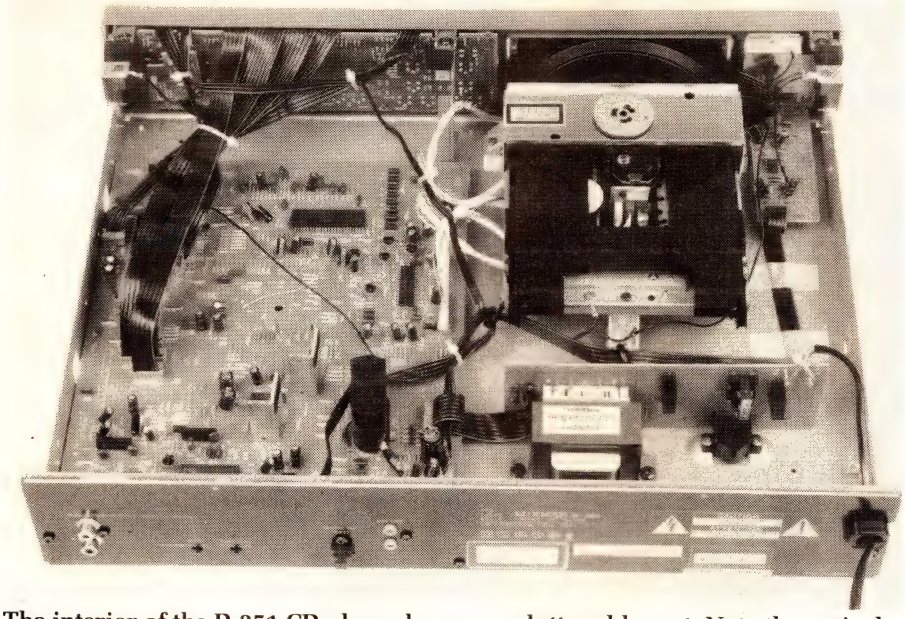
Dimensions of the Luxman D-351 CD player are 438mm wide, 90mm high and 346mm deep. It is a conventional front-drawer loading machine with the usual range of playing facilities, including random play and programmed play. If used with Luxman's system bus, it can also provide "CD synchro" recording to a cassette deck, as mentioned above.

In addition, the D-351 has "Edit Play", a playback feature not found on most machines. You can use "Edit Play" when programming the machine for recording on to tapes. For example, you can set a play time of 45 minutes and then program in tracks to be recorded. This avoids the common problem when taping CDs to cassettes and finding that the tape ends midway through a track.

It also has infrared remote control via its own RD-351 handpiece or via the comprehensive RA-371 remote control supplied with the amplifier. Funnily enough, as with most CD players having remote control, you can

FACING PAGE: the A-371 integrated stereo amplifier comes complete with IR remote control & delivers 70W RMS per channel. Below is the D-351 CD player which also features IR remote control.





The interior of the D-351 CD player has an uncluttered layout. Note the optical fibre socket & system bus sockets on the rear panel. The rear panel also carries a level switch which sets the maximum output signal to 2V or 1V RMS.

even open or close the drawer remotely although you still have to load the disc in or take it out, by hand.

You might think there is not much use in being able to open or close the drawer remotely and in the case of this player, even to turn on the power, but it does make sense to do so. Why? Because it stops you from putting your fingers on the front panel and thus preserves the finish as long as possible. If you don't think that is relevant, take a look at the most used buttons on your present gear or home appliances. After a few years, the wear and tear can become quite obvious.

Interestingly, if you are using the D-351 together with the A-371 amplifier and have them interconnected via the system bus, you get an extra level of playing convenience. Not only do you not have to turn each piece of equipment on or off separately, but if you select CD as the source, it will immediately start playing a disc or, if no disc is present, it will open the drawer ready to receive one.

The D-351 CD player has its own stereo headphone socket and volume control, a worthwhile feature, particularly if you want to use the CD player on its own. And if you want to use the CD player with a DAT recorder, you can link the two together via the D-351's optical fibre output.

A large easy-to-read digital display is a feature of the front panel and you can program it to play up to 24 tracks. Naturally, you can do all this from the remote control for the A-371 amplifier so you don't need more than one remote handpiece.

Two small switches on the rear panel of the D-351 provide facilities not found on other players. One switch allows the maximum output signal voltage to be reduced from 2V to 1V. This is useful because it is a closer match to the output signals from other program (line) sources such as tuners and tape decks. Thus there will be less change in volume level when switching between sources.

The second switch allows for timer operation. With the switch in the ON position, playback operation starts automatically when power is applied, if a disc is inside the machine.

Taken as a pair, the Luxman A-371 amplifier and D-351 CD player work very well together, as you would expect. They are quiet at all times and subjectively, they produce very good quality sound. And the measurements back up that impression.

Test results

Rated power for the A-371 stereo amplifier is 70 watts per channel for a total harmonic distortion of .01% over the frequency range of 20Hz to 20kHz into 8Ω loads. Our tests showed that the amplifier met this specification easily and with plenty to spare, as far as power output was concerned. We measured maximum power at 85 watts per channel at 1kHz with both channels driven and 96 watts with one channel driven, into an 8Ω load.

Power into 4Ω loads was somewhat higher, at just over 130 watts, and this also confirmed the Luxman specification. The signal-to-noise ratio was 82dB A-weighted with respect to 5mV and 1kHz for the phono inputs which was exactly as specified, while the S/N ratio for the line inputs (CD etc) was slightly over 101dB, a little better than the spec.

Maximum boost and cut for the bass and treble controls was a little over ±8dB. This is somewhat less than is typical for mainstream stereo amplifiers and receivers but we think that this is probably good practice. After all, on most hifi systems the tone controls are rarely, if ever, used and if you are routinely using your system with lots of bass boost, there is something wrong with it (or, dare we say it, something wrong with you!).

For its part, the D-351 CD player performed very well too, as you would expect from a system that claims dual D-A converters, 8-times oversampling and 18-bit digital filters. Its frequency response was within ±0.6dB from 20Hz to 20kHz and its signal to noise ratio for the same bandwidth was 92.5dB and 104dB with A-weighting.

We measured harmonic distortion at around .0035% for low frequencies but found that the figures rose quite considerably as the frequency was increased due to the presence of supersonic sampling artefacts at 44.1kHz. We were a little surprised by this in view of the fact that the D-351 is claimed to be an 8-times oversampling machine. Normally, 8-times oversampling means that the residual sampling artefacts are at 352kHz (44.1kHz x 8) and at a very low level.

Where the D-351 really does shine is with its linearity performance. This is measured with a compact disc with 1kHz signal levels that are progressively reduced, to an ultimate level of -90dB. By the time the level is reduced to -80dB most CD players have an error of around +2dB or so while at -90dB, the error can be as much as +5dB; ie, the actual measured signal level drops to -85dB instead of -90dB. At -80dB, the D-351 had an error of just +0.4dB while at -90dB the error was +2dB. This is very good.

The separation between channels

continued on page 92

ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTR

NEW

CAR SPEAKERS / SUBWOOFER SYSTEMS

JAYCAR is proud to announce a brand new range of high quality, low priced car speakers. Our new product staff have been working on car speakers for months, with many evaluated & rejected before we decided on the range shown here. Many so called car speakers are nothing more than junk & sound absoloutely terrible. With our direct importing, we've been able to cut out the middleman & offer you much lower prices than so called "Discount Car Radio Installers".

POWER RATING: Many car speaker manufacturers put unbelievably high power ratings on their speakers. They use the term PMPO, which in our opinion is really make believe when it comes to true power handling. In our specifications we have rated each woofer/driver in RMS watts, the midrange and tweeters get our normal system power rating, which is power handling when used with a matched crossover network. We will also have coming soon new tweeters, midrange and crossovers to match these speakers. Also included in the range is 3 subwoofers - with massive magnets all 4 ohms.

These are priced very competitively. Stock due first week of January 1994.

NIPPON AMERICA

PYRAMID USA

PHASE III

4" - 2 WAY CAR SPEAKERS

4" woofer with built in dome midrange. Supplied as a pair with grills and connecting cable. These sound excellent in small places - eg. doors.

Specifications:

Power Handling:	30WRMS
Freq Response:	100Hz-18kHz
Resonant Freq:	120Hz
Voice Coil Dia:	20mm
Efficiency:	90dB/W (1m)
Impedance:	4 ohm
Magnet Weight:	10 ounce
Mounting Depth:	38mm
Cat: CS-2250	

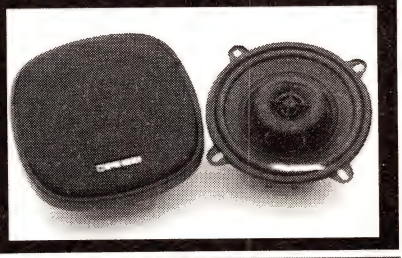
$39.95 per pair

5" - 2 WAY CAR SPEAKERS

5" woofer with built in dome tweeter. Excellent sound for a small speaker. Designed to operate in small spaces. Great power handling. Supplied per pair with grills and cable.

Specifications:

Power Handling:	40WRMS
Freq Response:	50Hz-20kHz
Resonant Freq:	70Hz
Voice Coil Dia:	20mm
Efficiency:	90dB/W (1m)
Impedance:	4 ohm
Magnet Weight:	10 ounce
Mounting Depth:	45mm
Cat: CS-2256	



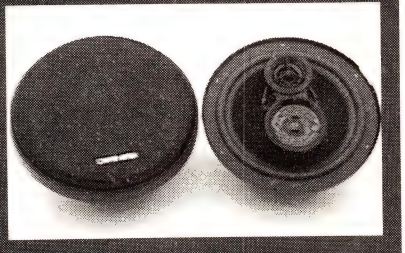
$44.95 per pair

6" - 3 WAY - DOOR MOUNT

With the added benefit of a midrange and a large cone area for better bass. Low 52mm mounting depth allows these to be mounted in most doors, kick panels etc.Supplied as a pair with grills and connecting cable.

Specifications:

Power Handling:	60WRMS
Freq Response:	80Hz-18kHz
Resonant Freq:	90Hz
Voice Coil Dia:	25mm
Efficiency:	90dB/W (1m)
Impedance:	4 ohm
Magnet Weight:	10 ounce
Mounting Depth:	52mm
Cat: CS-2260	



$59.95 per pair

6" - 3 WAY - REAR MOUNT

The largest and best of all our round car speakers. This speaker has a huge magnet and particularly good bass and power handling.Supplied as a pair with grills and cable.

Specifications:

Power Handling:	70WRMS
Freq Response:	600Hz-19kHz
Resonant Freq:	80Hz
Voice Coil Dia:	25mm
Efficiency:	91dB/W (1m)
Impedance:	4 ohm
Magnet Weight:	20 ounce
Mounting Depth:	80mm
Cat: CS-2262	

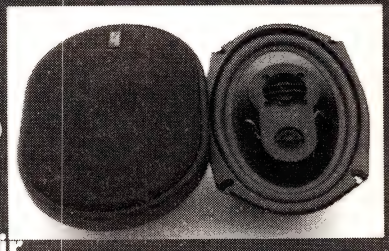
$75.00 per pair

6x9" - 3 WAY - POLYCARBON CONE

If you want the best sound in your stereo, and have the room, these are the speakers you need. Large 6 x 9" woofer with Polycarbon cone handles the power very well and gives excellent bass response.

Specifications:

Power Handling:	80WRMS
Freq Response:	45Hz-22kHz
Resonant Freq:	60Hz
Voice Coil Dia:	25mm
Efficiency:	93dB/W (1m)
Impedance:	4 ohm
Magnet Weight:	20 ounce
Mounting Depth:	82mm
Cat: CS-2268	



$119.00 per pair

SUBWOOFER SYSTEMS

The interior of any car is one of the most complex and difficult listening spaces to deal with when it comes to accoustic responses. Sound is reflected by large glass areas, absorbed by upholstery and is dramatically affected by the presence of passengers. And if that isn't enough, all kinds of noises are generated by the engine, tyres, car body, wind and so on - all of which have low frequency characteristics. The only way to resolve this problem is to have a subwoofer speaker system. To this, you must add a subwoofer type low pass dividing network for effective separation of low and high frequency signals. Jaycar have all these points covered with our new range of car speakers for door and rear mount subwoofers for extra bass, separate tweeters and midrange for building your own systems and crossovers to make it all work together properly. These subwoofers and our new crossovers will allow you to have that bass that you really need for great car sound.

PYRAMID SUBWOOFERS

We have three Pyramid subwoofers available. These are high performance units, all with huge 40 ounce magnets, laminated fibre compound cones and all with rubber edges.

Specifications:	8 Inch	10 Inch	12 Inch
Power Handling:	80WRMS	100WRMS	120WRMS
Freq Response:	40Hz-5kHz	35Hz-5kHz	35Hz-4kHz
Resonant Freq:	40Hz	35Hz	35Hz
Voice Coil Dia:	1 inch	1.5 Inch	1.5 Inch
Efficiency:	92dB/W (1m)	92dB/W (1m)	93dB/W (1m)
Impedance:	4 ohm	4 ohm	4 ohm
Magnet Weight:	40 ounce	40 ounce	40 ounce
	Cat: CS-2282	Cat: CS-2286	Cat: CS-2290
	$59.95	**$75.00**	**$89.95**

TWEETERS/MIDRANGE/CROSSOVERS

DUE NEXT MONTH!!!

Tweeters, midrange and crossover networks to supplement this series of car speakers and subwoofer systems.

CAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYC

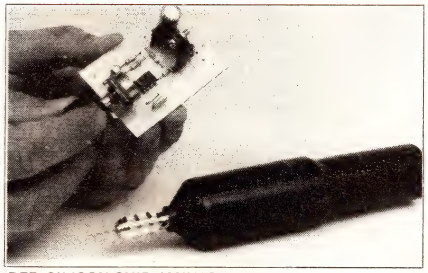
JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCA

NEW KITS NEW KITS NEW KITS NEW KITS NEW KITS NEW KITS NEW KITS

PRINTER STATUS INDICATOR KIT FOR PC'S

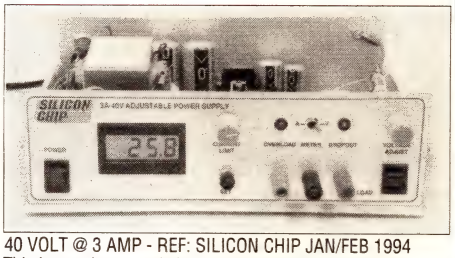
REF: SILICON CHIP JAN 1994
Have you ever waited for a complex graphics file to print out, only to find after ten minutes it's disappeared down your printer cable! This project uses an alphanumeric LCD to indiacte any errors - but it will notify you as soon as they happen - saving you valuable time. The unit connects between your PC and printer, and is powered by a 9 volt plugpack. Operation software is available from Silicon Chip. Kit includes case, LCD, DB25 sockets, front panel label, PCB and all specified components. Plugpack extra - use MP3007 $15.95. DB25 PC cable also required. Cat: KC-5145 **$69.50**

LOW VOLTAGE SPEED CONTROLLER



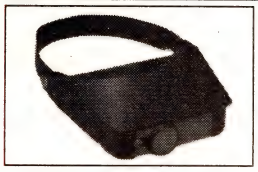
REF: SILICON CHIP JANUARY 1994.
SUITS - PCB DRILLS AND 12V LIGHTS
This simple project uses a handful of components and will comfortably control DC motors rated up to 1 amp. It can also be used to dim 12 volt lights, and its principle operation is the same as used in the dimmers for automatic desk lamps. Kit includes PCB and specified electronic components. Cat: KC-5146
$14.95

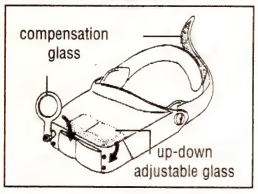
LCD VARIABLE POWER SUPPLY KIT



40 VOLT @ 3 AMP - REF: SILICON CHIP JAN/FEB 1994
This heavy duty supply is adjustable from 1.23V to 40V, features preset current limiting, high efficiency switching regulator, full overload protection and an LCD panel meter for precise voltage and current readouts. As this supply employs switchmode operation, the regulator generates less than 10W, eliminating the need for large expensive heatsinks (translating into simplified construction and smaller case). The Jaycar kit is supplied full-form ie: case, LCD, punched and screened front panel, PCB, plus all specified compoments.Cat: KC-5147 **$239.00**

HEAD MAGNIFYING GLASS





These headset glasses allow unrestricted user efficiency while reducing eyestrain. They leave both hands free, offer a wide field of vision and can be worn over prescription or safety eyeglasses. When not in use, they can be tilted up out of the way. There are 4 different magnifying multiples: X1.8, X2.3, X3.7 and X4.8. Looking through the single lens is X1.8. Swing the round magnifier down and it becomes X3.7. Clip the second large lens down (that folds up inside the headset) and you get X2.3. Again swing the round magnifier down and you have X4.8 magnification. The headstrap is adjustable, with a velcro tab for holding in place. These glasses have many uses from checking circuit boards to reading resistors plus all the other industries that require close magnification.

Cat. QM-3510 **$39.95**

CLEAN UP THAT WORKBENCH

Designed to hold all your "bits & pieces":- resistors, capacitors, semiconductors, drill bits, nuts & bolts, nails, etc.
The unit is grey with clear drawers. There are key holes in the rear for easy wall mounting. Drawers have a stopper so when pulled out they won't come all the way out spilling your components. Each drawer will accept up to 3 plastic dividers which can divide the drawer into 2, 3 or 4 separate compartments. 16 drawer dividers are supplied.

Drawer size 110(L) x 50(W) x 34(D)mm
Total size 185(H) x 242(W) x 124(D)mm
Cat. HB-6320
$13.95 ea
Jan Special - 6 for $66
Save $17.70

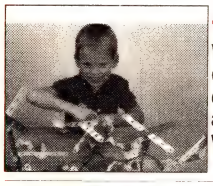
HOBBY BOX SPECIAL

Quality ABS black plastic box. Ideal for use in cars and supplied with underdash mounting bracket. It may look familiar to many people as it's a radar detector enclosure. The front panel has a square hole and the rear panel has some odd shaped holes, but cables can be run through and in a car they won't be seen anyway. Dimensions 39(H) x 125(W) x 127(D)mm. Includes top, bottom, front and rear panels, mounting bracket and two thumb screws. Cat. HB-5942
Normally $4.95 Jan $2.95 - save $2

12V DC DELUXE NICAD BATTERY CHARGER

This unit will charge one to eight NiCads at a time. It will charge 9V, N, AAA, AA, C and D batteries.This handy charger also includes battery tester and LED charge indicators. Charger comes with a 2.1mm DC socket on the side of the unit, which enables you to use any 12V DC source 500mA or more, eg. plug pack (MP3012 $22.50), car, boat or even a solar Panel. No need to rely of 240V AC to charge your NiCad batteries!! Cat MB-3514
Was $17.50, Jan $12.50, Save $5

4 IN 1 SOLAR CONSTRUCTION KIT



With this kit you can build a windmill, airplane, helicopter and watermill. You can also create your own construction designs. Easy to assemble. Comes complete with plastic nuts and bolts, wheels, solar panel, motor and spanner to assemble the kit. Suitable for ages 5 and up. Cat. KJ-6770
Was $24.95-Jan $20-Save $4.95

INNER EAR MINI STEREO PHONES

Unique type headphones, so small they can be stored in a matchbox. Very high sound quality & comfortable to use. Supplied with adaptor to 6.5mm & spare replacement ear pads. Cat: AA-2014
was $5.95 January $2.95 save $3.00

SAVE ON MAGGYLAMP

The Maggylamp is a widely adjusted magnifier with a 12.7cm diameter bi-convex lens, 4.00 dioptres focal length of 25.4cm. It is essentially a microscope with lighting. Maggylamp has flexible arms for easy positioning. Handsome, sturdy construction assures a lifetime of service. Cat: SL-2700
was $329 now $279 save $50

AUDIO LEAD BARGAIN

2 RCA plugs on one end to 1 x RCA socket on the other. Length 700mm.
Cat: WA-1019 **only $2.00**

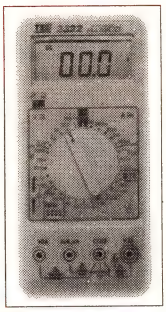
SEVEN SEGMENT DISPLAY SPECIAL

No. LT303 Common Cathode Red Display
Cat: ZD-1803
Normal Price $3.50
January 10 for $10

JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS

ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTR
ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTR
ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTR

DMM SELLOUT



•Frequency •Logic •Transistor
•3.5 Digit •One hand operation.
See catalogue for full details.
Cat. QM-1520

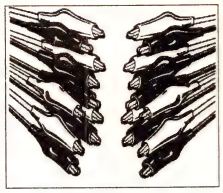
was $125
now $100
save $25

REPLACEMENT EARPHONE SPECIAL

4 black mini sponge pads for replacing soiled ones on your earphones - OD: 17mm
Cat. AA-2013

normally $1.50
January $0.50

JUMPER LEAD BARGAIN

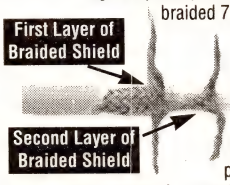


The quality of these leads is not up to the usual standard you would expect from Jaycar. The alligator clips are smaller than usual, the lead is only 350mm long instead of the usual 600mm and about 10% of the alligator clips will come away from the cable when a reasonable force is applied. They can easily be resoldered. 10 leads supplied. Grab yourself a bargain. Limited quantity.
Cat. WC-6012

Normal stock costs $7.95
These are only $2.95
Save $5.00

SUPER QUALITY 75Ω COAXIAL CABLE SPECIAL

We have bought a quantity of Super High Quality double braided 75 ohm coax that was specially made for Telecom. The quality as you would expect with Telecom is excellent, and if you have a long run or RFI problem then this cable should suit you. Cable details: •Impedance - 75Ω •Double braid shield •OD - 6.0mm •Colour - Telecom yellow •Reel length - 250 metres. You would expect to pay over $2 per metre for cable of this quality, but if you act now we have a limited quantity available at a very reasonable price.
Cat. WB-2007

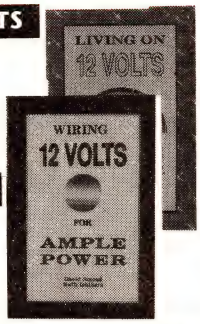


Price / 250m roll $100
Price / metre $0.60

SAVE $5 ON 12V BOOKS

LIVING ON 12 VOLTS
Cat. BC-1160
was $39.95
now $34.95

WIRING 12 VOLTS
Cat. BC-1162
was $29.95
now $24.95



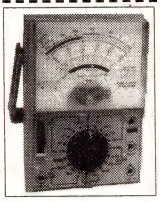
LETTER FOLDER MAIL OPENER

Stocks are very low!!!

Another surplus scoop purchase. These are made in Japan. If your business/office needs to fold normal A4 sheets to mail out, this machine will reduce expensive labour costs. It will fold up to 3 sheets at a time and folds them twice so they fit into an DL size (110 x 220mm) envelope. It will also open mail. Simply insert the envelope in the slot and it will grasp it and run it through and open it. It will open mail in about 1/2 the usual time taken. 240V operated. We have seen a similiar unit in a stationery catalogue - without the letter opener for $695. We feel that a realistic price for this machine is $399. However, these are only $99. Save about $500!!! Cat. YL-2900

only $99 save $500

SAVE $5 ON ANALOGUE 20KΩ/V MULTIMETER



Includes continuity buzzer and battery tester. See catalogue for full details.
Cat. QM-1022

was $39.95 now $34.95

FOR BULK BUYS CONTACT OUR WHOLESALE DEPT ON (02) 743-5222

BARGAIN PRICED TELEPHONE ACCESSORIES

US TELEPHONE LEAD

Used from wall socket to telephone

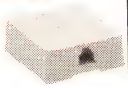
US PLUG TO US PLUG - $2.95
- Length - 10 feet (3 metres)
- Flat cable. Ivory colour. Cat. # YT-6080

CONNECTORS/ADAPTOR

US PLUG - RJ12 - 6x4
Norm. $3.50 Now $2.00
- Pkt 5. Cat. # PP-1432

ADAPTOR - US SOCKET TO SOCKET
Norm. $4.95 Now $2.95
- Cat. #: YT-6060

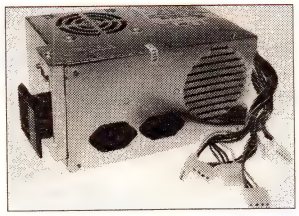
US SURFACE MOUNT SOCKET - Only $1.95
- Fawn in Colour. Size: 55x49x21(D)mm socket on end. Cat. # YT-6059



US WALL SOCKET - Only $1.95
- Size: 76(W)x120(H)x10(D)mm.
- Cat. # YT-6057

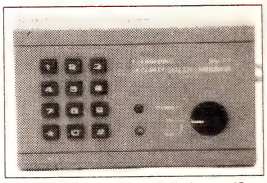
We have purchased a quantity of telephone leads and accessories at distressed prices, and have passed the savings on. Save up to 50%.
Note: These are not Austel approved.

COMPUTER POWER SUPPLIES SLASHED



200W AT Cat. XC-5082
was $159 now $99
150W PC/XT Cat. XC-5080
was $119 now $89

ALARM PANEL TELEPHONE DIALLER



This product which will connect to virtually any home -business alarm panel. It has a built-in microphone which records a 16 second message by you and then when the alarm is triggered will send the message up to four different numbers, or any combination of the same. Suitable for pulse or tone phone systems. Easy to connect to both alarm system (N/C terminals) & phone (2 wires). Requires 12VDC - from alarm panel.Stores 4 telephone numbers which can be easily sequenced. Not Austel Approved.
Cat: LA-5190 **Was $189 Now $159**

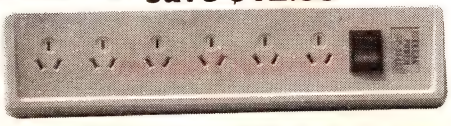
ROBO LIGHT SLASHED

PIR controlled battery operated light. Ideal for dark halls, stairs, cupboards etc. See catalogue for full details.
Cat. LA-5008 **was $34.95**
now $24.95 save $10

SIX WAY POWER OUTLET WITH MAINS FILTER

Not only is it a 6 way power board, it incorporates a voltage surge and spike protector and noise rejection filter network. Supplied with two metre cord and mains plug, safety shutters on each outlet, illuminated master on/off and even a safety circuit breaker.
Cat. MS-4030

Was $52.50
Jan Special $39.95
Save $12.55



RECHARGEABLE BATTERY CASE

This case will accept a 6.5Ah gel battery. It is ideal for video camera users or for hand held 12 volt spotlights for shooters, night bush walks etc. It has leads for connecting to the battery inside the case (positive lead is fuse protected) and a cigarette lighter socket is mounted on the side. It has removable strap for hanging on the shoulder and a belt loop.
Cat #: HB-5950 **$24.95**

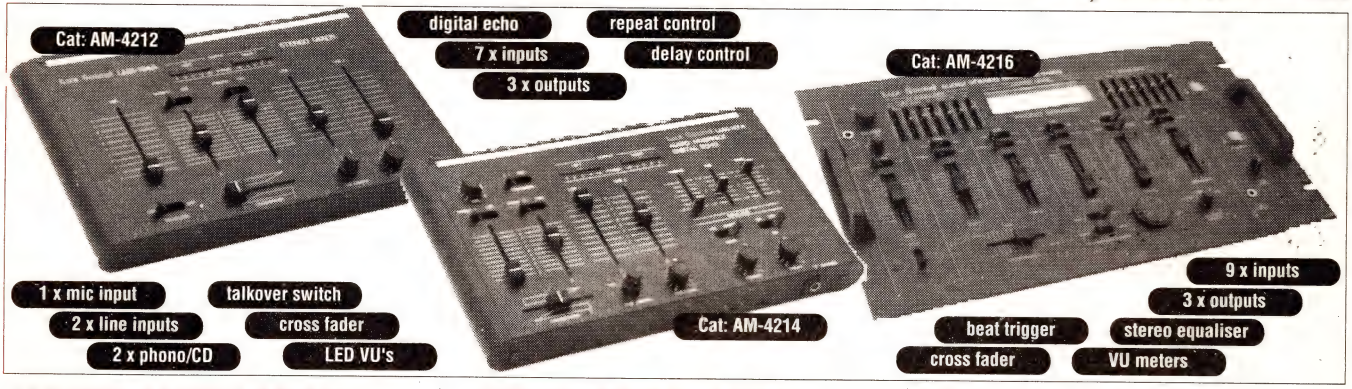
JAYCAR WILL NOT BE UNDERSOLD ON GOODS OF THE SAME QUALITY

CAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECT
CAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECT
CAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECT

JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCA

STEREO AUDIO MIXERS

STEREO AUDIO MIXERS



STEREO AUDIO MIXER

7 INPUT / 3 OUTPUT

This baby unit of the range has features not seen before at this price. It is ideal for disc jockeys, sound enthusiasts or home mixer applications.

Features: •1 mic input •2 line inputs •2 inputs which can be switched between phono and CD, so both can be used with "Y" adaptor plugs •talkover switch •crossfader between 2 CD/ phono inputs •headphone socket with volume control and switch to listen to any input channel •LED VU meters •small size

Cat: AM-4212 **$159.00**

Specifications for AM-4216:	
Inputs - mic	1.0mV/600Ω
Inputs - phono	3mV/47kΩ
Inputs - line/video	150mV/27kΩ
Output	1 volt
Freq Response	20-20kHz,+/-3db
Distortion	<0.09%
S/N Ratio	>60db
Talkover Atten	-12db
H/phone Monitor	1V/75 ohm
Power Source	240VAC
Size: 482(W) x 280(D) x 110(H)mm	

STEREO INPUT MIXER

DIGITAL ECHO, EQUALISER - 7 INPUTS, 3 OUTPUTS

This unit offers all the same features and specifications of the smaller unit - plus the following: •equaliser with bass, mid and treble controls which can be switched out •digital echo which is switchable to use on all inputs or just the mic input. It has a repeat level control which controls the level of echo, and it also has a delay control which effect the duration of the echo.

Cat: AM-4214 **$239.00**

Specifications for AM-4212:	
Inputs - mic	1.5mV/10kΩ
Inputs - phono	3mV/47kΩ
Inputs - CD	150mV/27kΩ
Inputs - line	150mV/27kΩ
Output	1 volt
Freq Response	20-20kHz,+/-2db
Distortion	0.01%
S/N Ratio	60db
Talkover Atten	-12db
H/phone Monitor	250mV/32 ohm
Power Source	240VAC
Size: 320(W) x 200(D) x 45(H)mm	

Specifications for AM-4214: Same as AM-4212 unit plus:	
Equaliser	
Treble	10kHz +/-12db
Midrange	1kHz +/-12db
Bass	100kHz +/-12db
Digital Echo	
Delay	Digital
Repeat	Digital
Power	240VAC

PRO AUDIO MIXER

STEREO 7 BAND EQUALISER, SWITCHABLE INPUTS, CROSSFADER, BEAT TRIGGER - 9 INPUT, 3 OUTPUT

This is a very professional mixer, loaded with features offering excellent value for money.

Features:

•two microphone inputs, one with adaptor for a gooseneck. Both have individual volume controls as well as one low cut switch which controls both •three inputs which can be switched between phono and line so both can be used with "Y" adaptor plugs •the equaliser is stereo with 7 bands per channel, frequencies are: 60Hz, 150Hz, 400Hz, 1kHz, 2.4kHz, 6kHz, 15kHz. Equaliser can be switched on or off •there is a slide crossfader which can be switched to operate between channels 1 and 3 and 2 and 4 •there is a beat trigger button which can be switched for inputs phono 1, 2 or 3 •illuminated VU meters •19" rack mount with handles •headphone (cue) output with volume control as well as one cue on/off switch per channel

Cat: AM-4216 **$379.00**

JAYCAR DEALERS

These dealers currently purchase goods from us on a regular basis. If they do not have the product in stock you wish to purchase, they may be happy to order goods in.

We cannot guarantee that our resellers will have the same prices as Jaycar, as they are privately owned businesses in all parts of Australia, and are subject to extra costs including freight, etc.

If you have a retail business and are interested in becoming a Jaycar Dealer contact Troy Weight (02) 743 5222.

A.C.T. **DOWNER (CANBERRA)** Canberra Information Tech Centre - 06 241 5900

NEW SOUTH WALES **ARMIDALE** New England Electronics - 067 71 1655 **BALLINA** Ballina Electronics - 066 86 7022 **BATEMANS BAY** Gregs Record Bar - 044 72 5689 **BATHURST** Electronic Frontiers - 063 32 3933 **BEGA** Gas Environmental Systems - 92 3525 **BELLINGEN** S.U.N.S. - 066 55 2266 **BOURKE** Country Wide Services - 068 72 2150 **BROKEN HILL** Hobbies and Electronics - 080 88 4098 **BYRON BAY** Byron Electronic Sales & Service - 066 85 7610 **CASINO** Casino Computers - 066 62 5220 **CESSNOCK** Cessnock Technology - 049 90 5971 **COFFS HARBOUR** Coffs Harbour Electronics - 066 52 5684 **COOMA** Hayden Electronics - 064 52 3095 **COWRA** Cowra Electronic Sales - 063 42 1455 **EDEN** Imlay Technical Services - 064 96 3431 **FORBES** Hal Brenner & Son P/L - 068 52 1277 **GLEN INNES** Thom & Pollock Installations - 067 32 1455 **GRENFELL** K & B Electronics - 063 43 2466 **GRIFFITH** Miatronics - 069 62 4534 **INVERELL** Inverell Electronics - 067 22 1821 **KEMPSEY** P & K Richards - 065 63 1134 **KYOGLE** Openshaw Electronics - 066 32 1772 **LAURIETON** Laurieton Bookshop & Tandy - 065 59 9777 **LISMORE** Lismore Service Solution-066 223 122 **MACKSVILLE** Macksville Electronics - 065 68 2899 **MACLEAN** Maclean Toy Kingdom - 066 45 3048 **MOSS VALE** Gamlen Electronics - 048 68 1786 **MUDGEE** Headware - 063 72 3895 **NEWCASTLE** Creative Lighting and Sound - 049 67 6577 , Vilec Distributors-049 566 808 **NOWRA** Haven Electronics - 044 21 5552 **PARKES** Strad Music Centre - 068 62 3366 **PORT MACQUARIE** Port Electronics - 836 875 **SPRINGWOOD** Sportsound - 047 51 5852 **TAREE** Manning Electronics - 065 51 2233 **TORONTO** Satellite TV Service-049 591 166 **TOUKLEY** Tomorrows Electronics - 043 97 1228 **ULLADULLA** Coastal Electronics & Hobbytoys - 044 55 3989 **WAGGA** Millers Appliance Centre - 21 2628 **WOLLONGONG** Newtek Electronics - 042 27 1620 **WOY WOY** Alphatran Electronics - 043 43 4919 **YOUNG** Keith Donges Electronics - 063 82 1279

VICTORIA **BAIRNSDALE** Green Gage Services - 051 52 5677 **BENALLA** Benalla Electronics - 057 62 4488 **COLAC** Colac Electronics - 052 31 2847 **HORSHAM** Wimmera Hobby Supplier - 053 82 2319 **MILDURA** Pullman AutoPro - 050 23 2882 **KERANG** Campbell Reproductions & Rhythms - 52 1522 **SHEPPARTON** Andrew Guyatt Electronics - 058 21 9497 **STAWELL** Stawell Tandy - 053 58 3144 **SWAN HILL** Nyah District TV Service - 050 32 9303 **WANGARATTA** Electrodynamics - 057 21 7750 **WARRNAMBOOL** Koroit St Electronics - 055 627417

QUEENSLAND **BARCALDINE** Barcaldine Electronics - 076 51 2134 **BUNDABERG** Bob Elkin Electronics - 071 52 1785 **CABOOLTURE** Kingtronics Pty Ltd - 95 6636 **CAIRNS** Merndex Pty Ltd - 070 31 1577 **DALBY** Universal Services - 076 62 3228 **GLADSTONE** Electronic Enterprises - 079 72 6660 **MACKAY** Mackay Communication Systems - 079 51 3544 **MAROOCHYDORE** Mal's Electronics - 074 43 6119 **MARYBOROUGH** Keller Electronics - 071 21 4559 **MOOLOOLABA** Custom Guitarcraft - 074 44 8889 **ROCKHAMPTON** Attwoods TV & Video & Repair Service - 26 1163 **STANTHORPE** Granite Belt Communications - 076 81 3333 **TOOWOOMBA** Vidcam P/L Hooper - 076 39 1960

SOUTH AUSTRALIA **KADINA** Kadina Tandy - 088 21 1666 **MT GAMBIER** South East Electronics - 087 25 0034 **MURRAY BRIDGE** Santronics Shop - 085 31 0445 **NURIOOTPA** Paul Douglas Locksmiths - 085 62 2269 **PORT AUGUSTA** Alternative Choices-086 410 251 **PORT LINCOLN** Bassham's TV & Computer - 086 83 0075 **PORT PIRIE** Elec Tec - 086 32 2425 **WHYALLA** Whytronics - 44 0988

WESTERN AUSTRALIA **ALBANY** Micro Electronics - 098 41 2077 **BUNBURY** Micro Electronics - 097 21 6222 **COLLIE** Collie Electronics - 097 34 1220 **GERALDTON** Angora P/L - 099 21 1278 **KARRATHA** Karratha Electronics - 091 85 2617 **MANJIMUP** Warren Electrical Service - 097 71 1289 **ROCKINGHAM** TV Joe - 095 27 1806 **WONGAN HILLS** Maxwell Elect - 096 71 1358 **YORK** York Electrical Service - 096 41 2077

TASMANIA **BURNIE** Elec City Shop - 004 31 9222 **DEVONPORT** Triple 5 Electronics - 24 2555 **HOBART** George Harvey Elec - 002 342233 **LAUNCESTON** George Harvey Elec - 31 6533

NORTHERN TERRITORY **ALICE SPRINGS** Alicetronics - 089 52 3411 **DARWIN** Radar Radio Elec Mechanical Services - 089 41 2620

JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS

Active Filter Design For Beginners

Active filters are widely used throughout electronics. In this article, we look at the basics of active filters & clear away some of the mystery surrounding this very interesting topic.

By ELMO V. JANSZ

A filter is one of the most common types of circuit used in electronic equipment. By definition, a filter passes some frequencies and suppresses or attenuates others.

Filters can be active or passive, depending on their construction. Passive filters use passive components such as resistors, capacitors and inductors, whereas active filters include an amplifying device, such as a transistor or operational amplifier, in addition to a number of passive components. The presence of the amplifier gives the filter very good isolation between its input and output and a certain amount of amplification as well.

In this article, we shall learn how to design active filters using simple calculations.

Let us start by establishing a few basic ideas about active filters. Fig.1 shows the idealised amplitude response of a low-pass filter. A low-pass filter is one that passes all frequencies up to a point and heavily attenuates

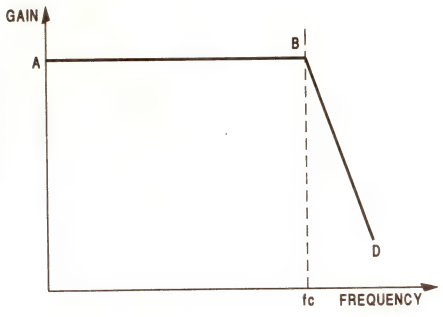


Fig.1: idealised amplitude response of a low-pass filter.

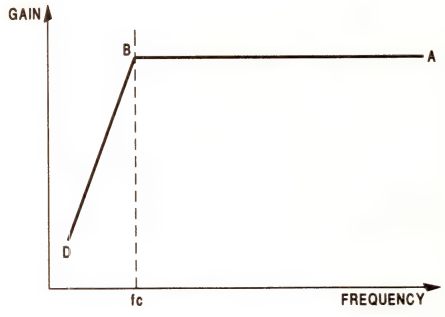


Fig.2: idealised amplitude response of a high-pass filter.

or suppresses frequencies beyond this point. The amplitude response is a plot of the gain of the filter against frequency. The gain is calculated by dividing the output voltage by the input voltage in the equation:

$$G = 20 \log_{10}(V_o/V_i)$$

where G is the gain expressed in decibels; V_o is the output voltage; and V_i is the input voltage.

In Fig.1, the frequency f_c is called the cut-off frequency while region AB in which the gain is constant is called the filter's passband. Beyond f_c, the gain drops rapidly and this region is called the stop-band.

The rate at which the line BD falls is measured in dB/octave or dB/decade. The is the "slope" of the filter. An octave is a doubling or halving of frequency; ie, for a frequency of 2kHz, octaves above are 4kHz, 8kHz and so on, while octaves below are 1kHz, 500Hz, etc. Decades are a ten-fold increase or decrease in frequency. For a fre-

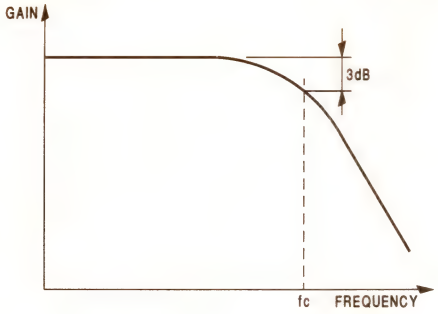


Fig.3: response characteristic of a practical low-pass filter.

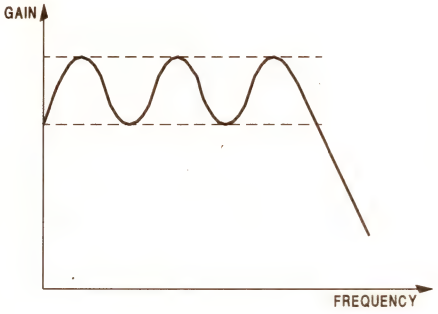


Fig.4: a filter with ripples in the passband is called a Chebyshev filter.

quency of 2kHz, decades above are 20kHz, 200kHz and so on, while decades below are 200Hz, 20Hz, 2Hz, etc.

We now come to another important definition, the "order" of a filter. This is the rate at which the line BD in Fig.1 falls off, or the filter's ability to attenuate frequencies outside its passband.

A "first order" filter has an attenuation outside its passband of 6dB/octave or 20dB/decade. The order of a filter is also referred to as its roll-off or fall-off.

A "second order" filter has a roll-off of 12dB/octave or 40dB/decade; ie, twice that of the first order filter. A third order filter will have a roll-off of three times that of a first order filter and so on for higher order filters.

A high-pass filter is the complement of a low-pass filter and will have an idealised response characteristic as shown in Fig.2.

Notice that frequencies below f_c are attenuated heavily. The roll-off has the same values as stated above but in this case will have the opposite sign.

A practical low-pass filter will have the response characteristic shown in Fig.3. The cut-off frequency in this case is not a sharp transition point as shown in Figs.1 & 2 but the frequency at which the gain is reduced by 3dB, from its passband value.

A filter with a response as shown in Fig.3 – ie, one having a flat response in the passband – is called a Butterworth filter. A filter could also have a response as shown in Fig.4, with ripples in the passband. This is called a Chebyshev filter.

The shape of the filter's response is determined by a constant (alpha) called the Damping Factor. There are other filters called Cauer, Bessel and Thompson filters but in this article we shall confine ourselves to Butterworth filters, as they are the most popular due to their design simplicity.

The general equation for a Butterworth low-pass filter of order n is given by:

$$\text{Gain} = 20 \log [G/(1 + W^{2n})^{1/2}]$$

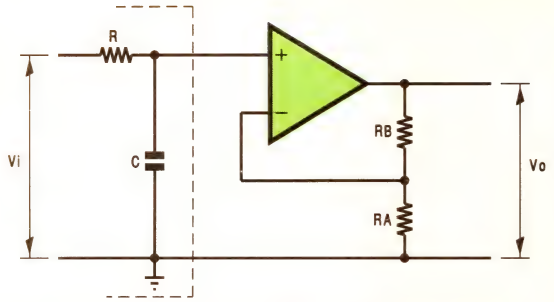


Fig.5: basic circuit for a first order low-pass Butterworth active filter.

where G is the passband gain in decibels; W is the normalised angular frequency; and n is the order of the filter. The normalised frequency is given by W/W_C where W is the frequency in question and W_C is the cut off frequency

Design of a first order filter

Let us now design a first order low-pass Butterworth active filter. The basic circuit is shown in Fig.5. The portion within the dotted line is a low-pass passive filer. The operational amplifier is connected in the non-inverting mode.

The cut-off frequency (f_C) and passband gain (G) are given by the following formulas:

$$f_C = 1/(2\pi RC)$$

$$G = 1 + R_B/R_A$$

Suppose we wish to construct a low-pass filter with a cut-off frequency of 2kHz. We start by selecting a value for C. Let this be .022μF. By using the formula $f_C = 1/(2\pi RC)$, we arrive at:

$$R = 1/(2\pi \times 2 \times 10^3 \times 0.022 \times 10^{-6}) = 3.617k\Omega$$

This would be selected as 3.6kΩ, using the closest value in the E24 (5%) range.

Let us set the passband gain required equal to 2. Therefore, using the formula for gain:

$$R_B/R_A = G - 1 = 2 - 1 = 1$$

Therefore, we can make R_A equal to R_B and set both at 10kΩ. A 741 could be used for the operational amplifier and then you have your basic first order low pass filter. By interchanging C and R, you can produce the corresponding high pass filter.

Second order low-pass filter

The basic circuit of a second order low-pass filter is shown in Fig.6. Here again a network of passive components is placed around an op amp. Second order active

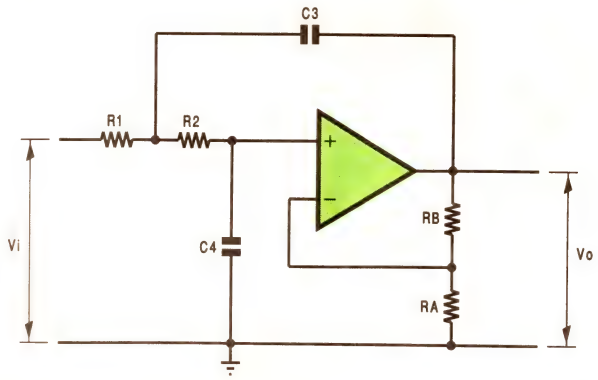


Fig.6: basic circuit of a second order low-pass filter.

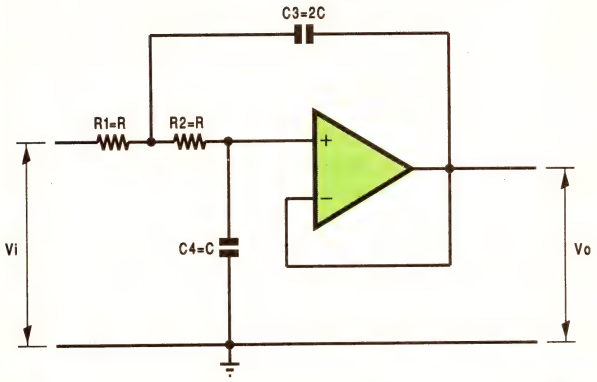


Fig.7: the circuit for a unity gain low-pass active filter.

filters are also often referred to as Sallen-Key filters. This circuit has two RC networks, hence it is a second order filter. The cut-off frequency f_c for this filter is given by:

$$f_c = 1/2\pi(R1.R2.C3.C4)^{1/2}$$

and the mid-band gain is given by:

$$G = 1 + R_B/R_A$$

In practice, two versions of this circuit are possible: either a filter with a passband gain of unity, or a filter with equal components; ie, R1 = R2 and C3 = C4.

Unity gain

For this example, it is customary to make R1 = R2 and then C3 and C4 are fixed in the ratio C3 = 2C4, in order to satisfy the damping factor (alpha) requirements for a Butterworth response. The required circuit is shown in Fig.7. Note that the op amp has been configured for unity gain, as a voltage follower, by connecting its inverting input to its output.

Using the formula $f_c = 1/2\pi(R1.R2.C3.C4)^{1/2}$ and remembering that R1 = R2 = R and C3 = 2C4 (ie, if C4 = C then C3 = 2C), the above equation can now be written as:

$$f_c = 1/2\pi(R \times R \times 2C \times C)^{1/2} = 1/2\pi CR\sqrt{2}$$

If we select R = 10kΩ and if a cut-off frequency of 1kHz is desired, C can be calculated from the above equation to give: $C = 1/(2\pi \times 10^3 \times 10 \times 10^3 \times \sqrt{2}) = 0.01\mu F$.

Therefore, we can select C3 = 0.02μF and C4 = 0.01μF. The final design is now R1 = R2 = 10kΩ; C3 = 0.02μF; C4 = 0.01μF.

Equal component filter

If R1 = R2 = R and C3 = C4 = C, then the equation $f_c = 1/2\pi(R1.R2.C3.C4)^{1/2}$ becomes $f_c = 1/2\pi RC$

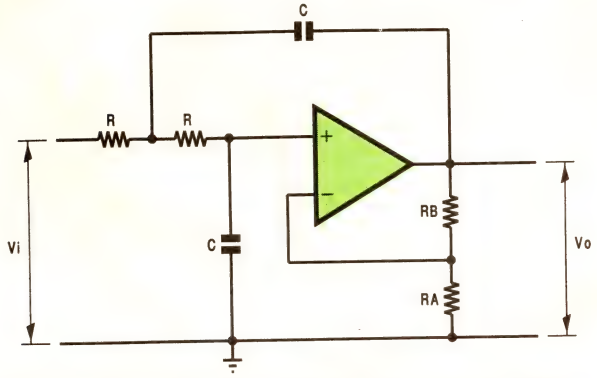


Fig.8: equal component low-pass Butterworth filter.

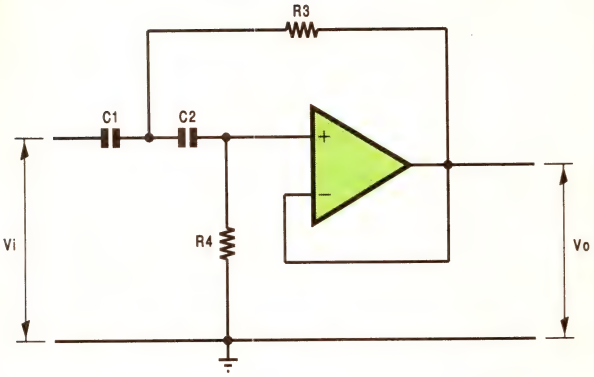


Fig.9: unity gain second order high-pass filter.

The passband gain for a Butterworth filter is defined by the equation:

$$G = 3 - \alpha$$

and since $\alpha = \sqrt{2}$, G = 1.586. Unfortunately, this is the only gain that will permit the circuit to operate correctly.

By selecting R = 5kΩ and a cut-off frequency of 1kHz, the above equation gives C = .032μF. A .033μF polyester capacitor would be suitable. The gain of G = 1.58 can be satisfied by making R_B = 27kΩ and R_A = 47kΩ (using preferred values). The final circuit is shown in Fig.8.

Second order high pass filters

High pass filters can be set up by interchanging the R and C components of the low-pass circuit. Two versions of this circuit are possible, as for the low-pass configurations – ie, a unity gain circuit and an equal component circuit. These are shown in Figs. 9 & 10.

For Fig.9, if C1 = C2, then R4 = 2R3 in order to satisfy the damping requirements for a Butterworth response.

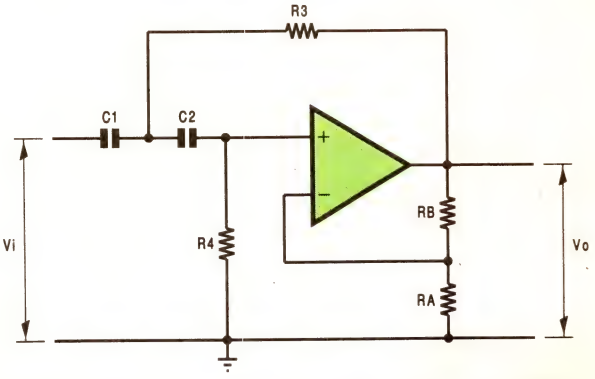


Fig.10: equal component high-gain Butterworth filter.

For the equal components version of Fig.10, if R3 = R4 and C1 = C2, then the gain is fixed by the equation:

$$G = 3 - \alpha$$

With alpha = $\sqrt{2}$, this again fixes the gain at 1.586.

Higher order filters can be obtained by cascading appropriate filter sections. For example, a fifth order filter can be produced by cascading two second order and one first order sections.

Filters can also be set up to pass a band of frequencies and so are called band-pass filters. A band-pass filter can be obtained by cascading an appropriate high-pass and low-pass section. **SC**

Are you interested in charging batteries from a solar panel? Here is a regulator designed especially for the job. It can be built in two versions (10-amp or 20-amp) & can be used to charge a 12V or 24V battery bank.

Switching regulator for solar panels

Design by OTTO PRIBOJ

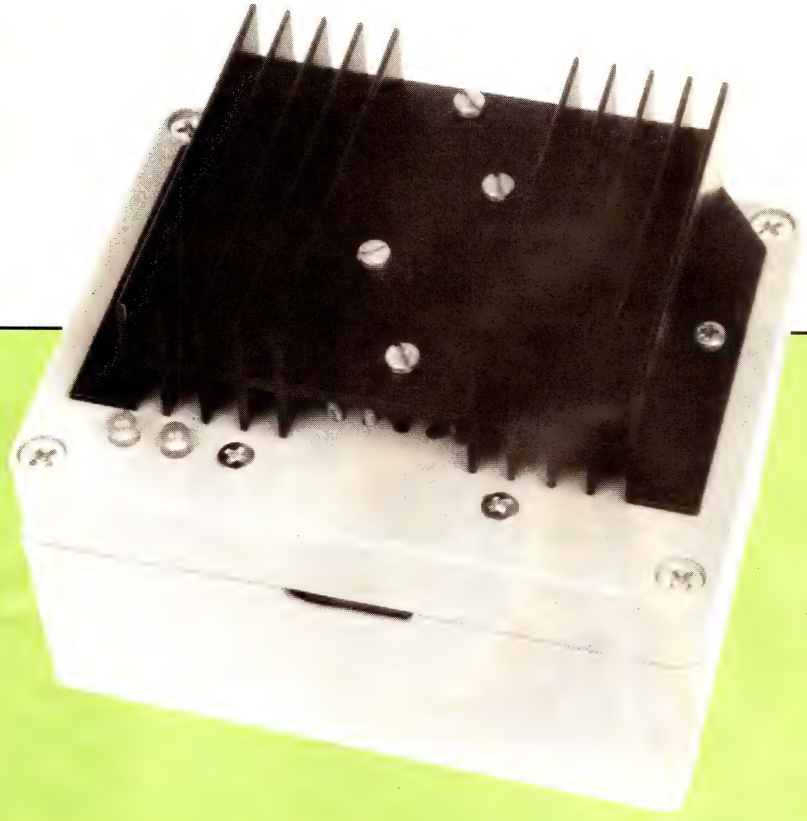
IN THE SIMPLEST solar panel plus battery setup, all you need is a diode to isolate the panel from the battery. This prevents the battery from discharging via the solar panel when it is not illuminated by the Sun. This is OK for a temporary setup but unless the solar panel is only trickle charging the battery, you will eventually run up against the problem of over-charging.

To avoid over-charging the battery you need a regulator circuit so that the panel can charge the battery at its maximum current output until it reaches full charge. At that point, the regulator disconnects the panel from the battery and no further charging takes place. That is the function of the circuit presented here.

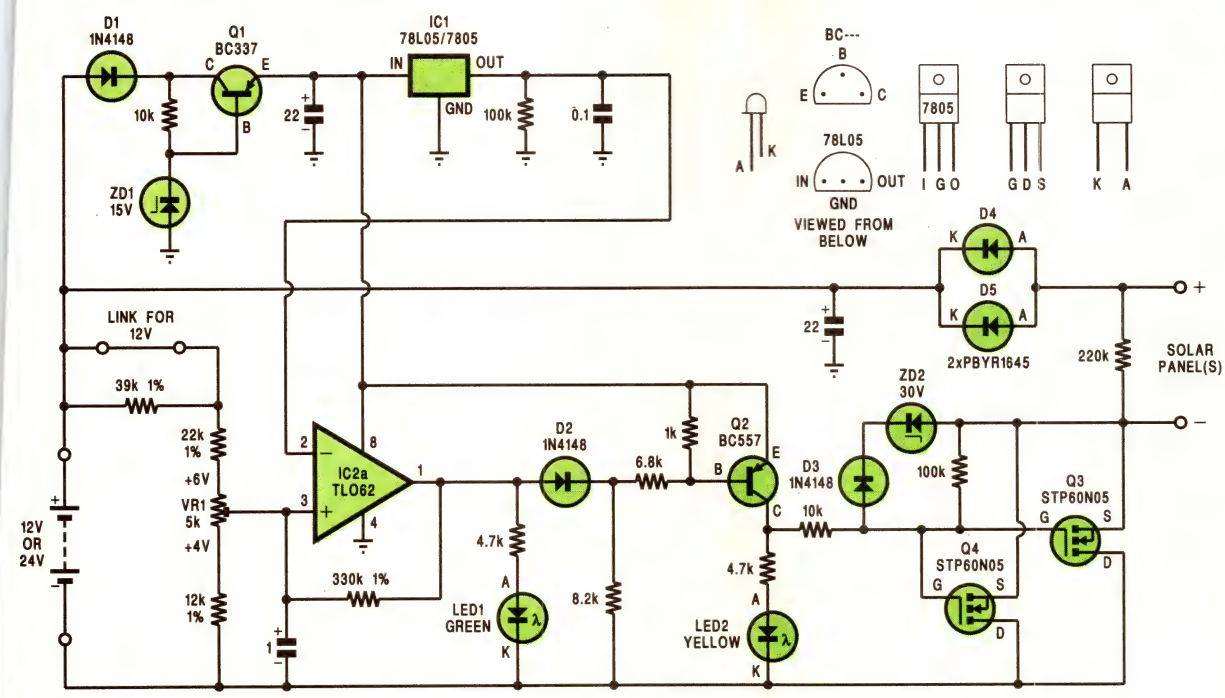
As depicted in the photos in this article, this regulator is built up on a small PC board with a number of power semiconductors which need to be mounted on a heatsink. The board itself would normally be mounted inside a plastic case with the heatsink on the outside.

How the circuit works

In effect, this circuit works like a switch. If the battery voltage is below 13.6V, the solar panel is connected. Once the battery voltage rises above that point, the solar panel is disconnected. A Schottky power diode, used because of its low forward voltage loss, prevents the battery from discharging back via the panel when there is no sunlight. To see how the circuit works, have a look at the diagram of Fig.1.



The regulator circuit can be housed in a plastic case but note that the power devices must be mounted on a large finned heatsink to provide cooling. The two indicator LEDs protrude through the lid of the case near one corner of the heatsink.



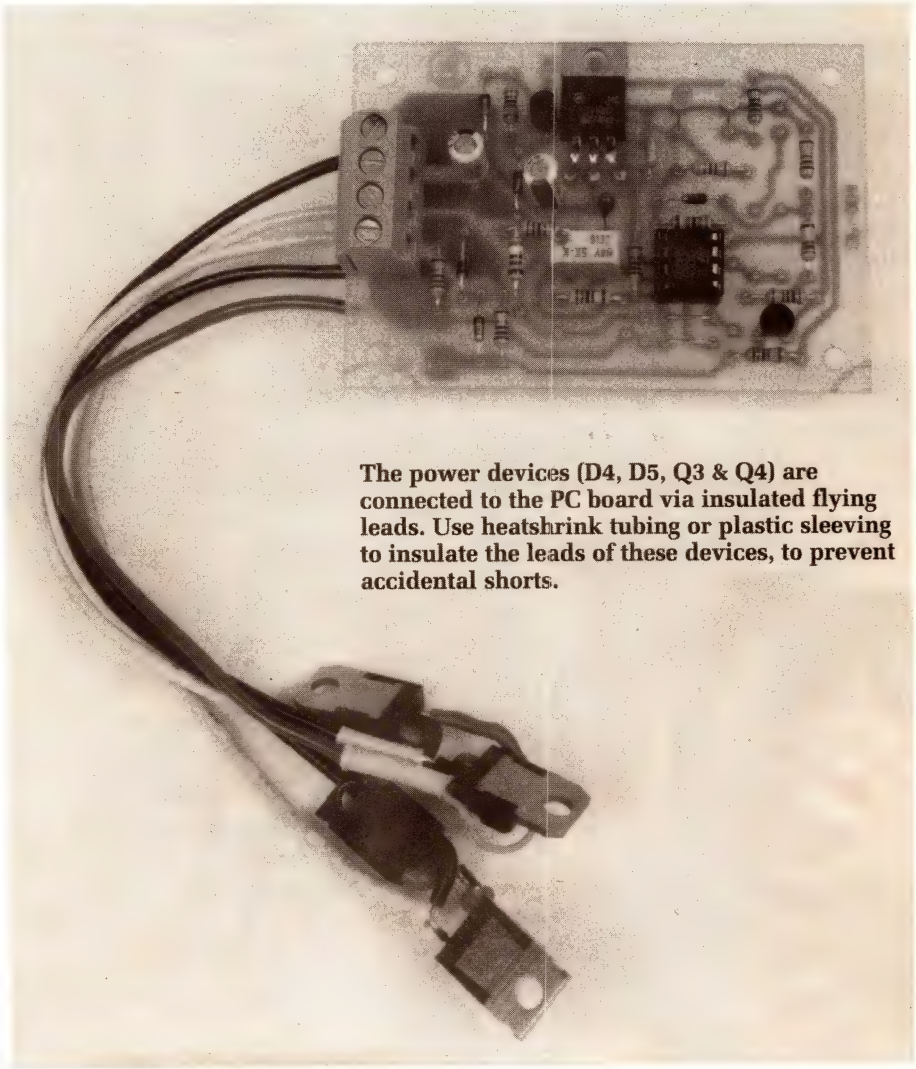
SOLAR PANEL REGULATOR

Fig.1 (above): the circuit is based on comparator IC2a. When the battery voltage is below 13.6V, IC2a's output is low & so Q2 turns on Q3 & Q4 to connect the solar panel. Conversely, when the battery voltage is above 13.6V, the output devices switch off & the solar panel is disconnected.

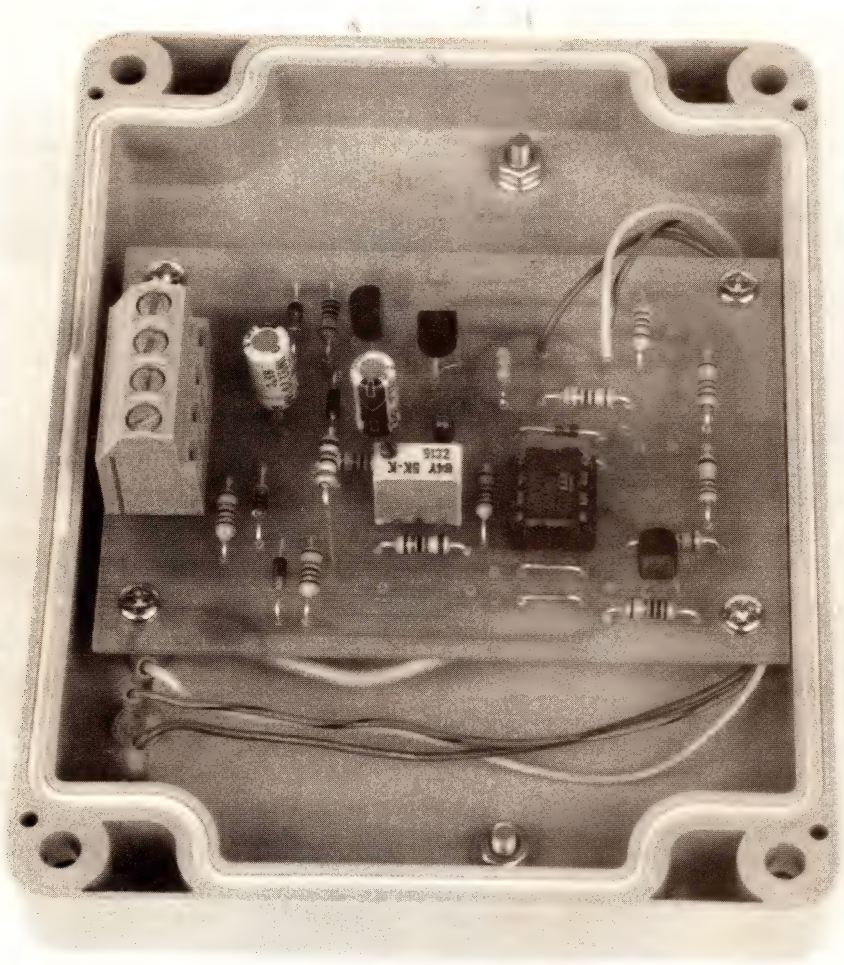
While the circuit may look a little daunting, it is really quite simple in operation. Notice that the positive terminal of the solar panel connects via Schottky diode D4 (and D5 for a high current version – ie; greater than 10 amps) to the positive terminal of the battery. The negative terminal of the panel connects to the negative terminal of the battery via Mosfet Q3 (and Q4 for the high current version) and it is the Mosfet which is the switching element. It is turned on or off, depending on the charge state of the battery.

Op amp IC2a is the heart of the circuit and it is connected as a comparator. It compares a reference voltage produced by a 5V 3-terminal regulator (IC1) at pin 2 with a proportion of the battery voltage at pin 3. When the voltage at pin 3 is above the reference voltage at pin 2, the output at pin 1 is high and transistor Q2 is off. Hence Mosfet Q3 (and Q4 if used) is also off and so the solar panel is effectively disconnected from the battery.

Conversely, if the voltage at pin 3 is below the voltage on pin 2, the output



The power devices (D4, D5, Q3 & Q4) are connected to the PC board via insulated flying leads. Use heatshrink tubing or plastic sleeving to insulate the leads of these devices, to prevent accidental shorts.



The assembled PC board is mounted on the lid of the case on 10mm tapped standoffs. Note that a small slot must be cut in the base opposite the terminal block to provide entry for the leads to the battery & to the solar panel.

at pin 1 is low and so Q2 turns on Q3 (and Q4 if used) so that the solar panel is now connected.

The rest of the circuit really amounts to a few frills. LED 1, at the output of IC2a, indicates "float/full charge". It turns on when the solar panel is disconnected. LED 2, driven by transistor Q2, is turned on while ever the solar panel is connected to the battery. It indicates "on charge".

We should note that the circuit has been designed around a TL062 dual low current Fet-input op amp but only one op amp, IC2a, is actually in use. The other op amp is disabled by tying its inputs (pins 5 & 6) low.

24V operation

As noted above, the circuit can be used for 24V systems and for this you would need two 12V solar panels in series and a 24V battery (or two 12V batteries in series).

When 24V operation is required, the input voltage divider from the battery is changed, to take account of the higher voltage. Note the 39kΩ resistor connected to the positive side of the battery. This is in circuit for 24V operation or replaced with a link for 12V operation.

Finally, D1, Q1 and ZD1 form a nominal 15V regulator to supply op amp IC2a and transistor Q2. For 12V operation, this circuit can be omitted or left in place – the circuit will function either way. The voltage at the emitter of Q1 will be only about +10V for a 12V battery input.

Current capacity

As noted above, the circuit can be configured to handle the output of panels rated up to 10 amps with one Mosfet (Q3) or increased to 20 amps with two Mosfets (Q3 & Q4). If two Mosfets, are used then two Schottky diodes will also be required. (D4 & D5). If more than one solar panel is used, then an alternative arrangement of one Schottky diode in series with each panel should be used.

Construction

All parts with the exception of Mos-

RESISTOR COLOUR CODES

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	330kΩ	orange orange yellow brown	orange orange black orange brown
❑	1	220kΩ	red red yellow brown	red red black orange brown
❑	2	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	39kΩ	orange white orange brown	orange white black red brown
❑	1	22kΩ	red red orange brown	red red black red brown
❑	1	12kΩ	brown red orange brown	brown red black red brown
❑	2	10kΩ	brown black orange brown	brown black black red brown
❑	1	8.2kΩ	grey red red brown	grey red black brown brown
❑	1	6.8kΩ	blue grey red brown	blue grey black brown brown
❑	2	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown

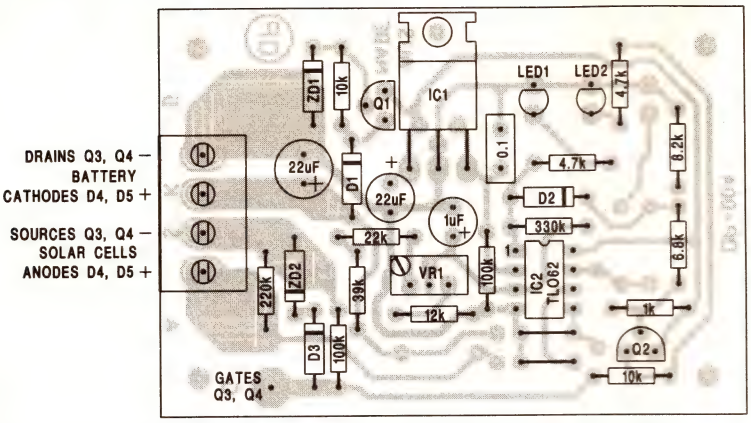
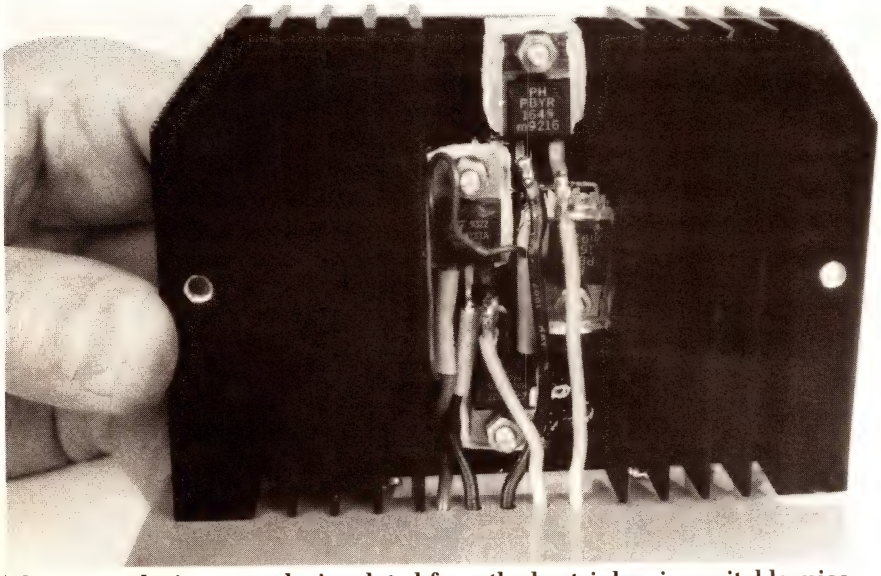


Fig.2: install the parts on the PC board as shown in this wiring diagram. The connections to the power devices (D4, D5, Q3 & Q4) are made via flying insulated leads which are soldered directly to the pins of the terminal block on the back of the PC board.



The power devices must be insulated from the heatsink using suitable mica washers & insulating bushes. Smear all mating surfaces with thermal grease before bolting the assemblies together, then use your multimeter to confirm that each device is indeed correctly isolated.

fets and Schottky diodes are mounted on a small PC board measuring 78 x 54mm. A 4-way insulated terminal black is mounted at one end for the four external connections to the battery and solar panel.

Trimpot VR1 is a multi-turn top adjust type which gives easy and precise setting of the "end-of-charge" battery voltage. The 3-terminal 5V regulator may be a 7805 or a 78L05 type, although the latter is preferable since its current drain is lower which could be important in this application.

Two prototypes are depicted in the photos accompanying this article. One is shown as a board only, with the power semiconductors attached by flying leads. They will need to be mounted on a suitable heatsink with the usual insulating bushes, mica washers and thermal grease.

The second prototype is shown with the PC board mounted in a plastic box and the two LEDs have been taken off the board and mounted so that they protrude through the lid of the case.

Setting up

To set the circuit up you will need a power supply to substitute for a solar panel and a 12V battery (since the circuit will not work unless a battery is connected).

Turn on the power supply and wind up the voltage. Note that no current will flow until the power supply exceeds the battery voltage. Turn up the supply voltage so that it is a few volts higher and measure the voltage across the battery. Adjust trimpot VR1 so that the battery voltage does not exceed 13.8V while on charge.

For a 24V system, the approach is the same except that the cutoff voltage is adjusted to 27.6V. **SC**

PARTS LIST

1 PC board, code OP-004
1 PC mount 4-way terminal block
1 heatsink (see text)
1 5kΩ multiturn trimpot (VR1)

Semiconductors

1 78L05 3-terminal 5V regulator (IC1)
1 TL062 Fet-input op amp (IC2)
1 BC337 PNP transistor (Q1)
1 BC557 PNP transistor (Q2)
1 STP60N05 N-channel Mosfet (Q3; add Q4 for 10A version)
1 PBYR1645 Schottky diode (D4; add D5 for 10A version)
3 1N4148 diodes (D1,D2,D3)
1 BZX79C15 15V Zener diode (ZD1)
1 BZX79C30 30V Zener diode (ZD2)
1 green LED (LED1)
1 yellow LED (LED2)

Capacitors

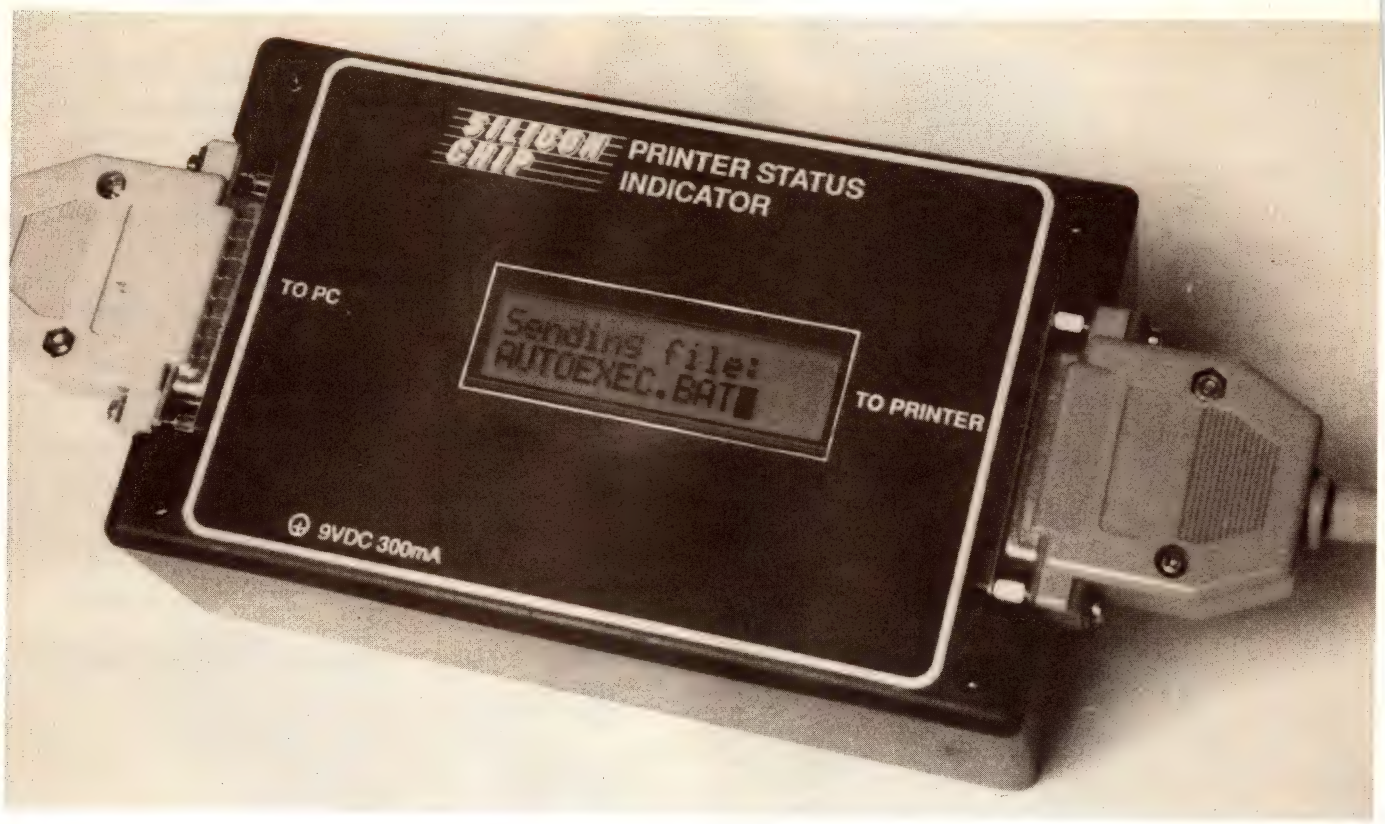
2 22µF 35VW PC electrolytic
1 1µF 35VW PC electrolytic
1 0.1µF monolithic

Resistors (0.25W, 1%)

1 330kΩ	2 10kΩ
1 220kΩ	1 8.2kΩ
2 100kΩ	1 6.8kΩ
1 39kΩ	2 4.7kΩ
1 22kΩ	1 1kΩ
1 12kΩ	

Where to buy the parts

Short form kits for this project are available only from the designer, Otto Priboj. The kit consists of the regulator PC board plus components and is priced at $54. Additional components to make a 20A version are priced as follows: STP60N05 $8; PBYR1645 Schottky diode $5.00; postage & packing, $4.00. Mail orders with a cheque or money orders should be sent to Otto Priboj, PO Box 362, Villawood, NSW 2163. Phone (02) 724 3801.



A printer status indicator for PCs

Have you ever been frustrated by files disappearing down your printer cable & not appearing at the other end? This Printer Status Indicator uses an alphanumeric display to indicate any errors that occur during transmission.

By DARREN YATES

When it comes to printing, most programs leave you flat if something goes wrong while the file is being sent to the printer. And with many graphics print files exceeding 4Mb, it can be extremely annoying after sitting around for 10 minutes or so for the printer to compile the pages and then nothing happens!

If you are using Windows, you will know that it does have a fairly good and reliable Print Manager to take care of these things. However, booting up Windows just to use the Print Manager is an exercise in time-wasting.

If you're running a small business with a number of PCs, the odds are that only one of the machines is connected to the printer. Those who need to print a file can then "Print to file" on their own machine, copy that file to a floppy disc and then transfer the file to the PC that's hooked to the printer.

The problem arises when you use the DOS commands COPY <filename.ext> LPT1 or PRINT <filename.ext>. They give you little or no indication as to what's going on. Try this for a test. Disconnect the printer from your PC and go into the root directory of your boot drive. Type "COPY AUTOEXEC.BAT LPT1" and press <enter>. You should find that you get a message saying that the machine is now happily sending your file to the printer. You will have to wait quite a while to see it though – an eternity, in fact.

Our Printer Status Indicator won't prevent errors from occurring but it will notify you as soon as they hap-

)en. The basis of the project is a driver)rogram called PRINTER.EXE and a 16-character x 2-line alphanumeric lisplay.

The Printer Status Indicator connects between your PC's printer port and the printer (via DB-25 sockets) but becomes transparent to the printer port when a print file is being sent.

Circuit diagram

The circuit for the Printer Status Indicator in Fig.1 shows that very little additional electronic circuitry is involved. Putting it simply, the computer sends data to the printer via an 8-way Tri-state buffer. This is enabled via the SI line (pin 17) from the printer port.

The SI (Select In), I (Initialise) and AF (auto-feed) control lines do not have to go directly from the computer to the printer socket for the printer to work correctly. As long as these lines are at the correct logic state, the printer will behave as normal. The only control line that must be fed straight through to the printer socket is the STROBE line.

The SLCT, PE, BUSY, ACK and ERROR lines are outputs from the printer back to the PC and are used to indicate any problems the printer may experience during a print run.

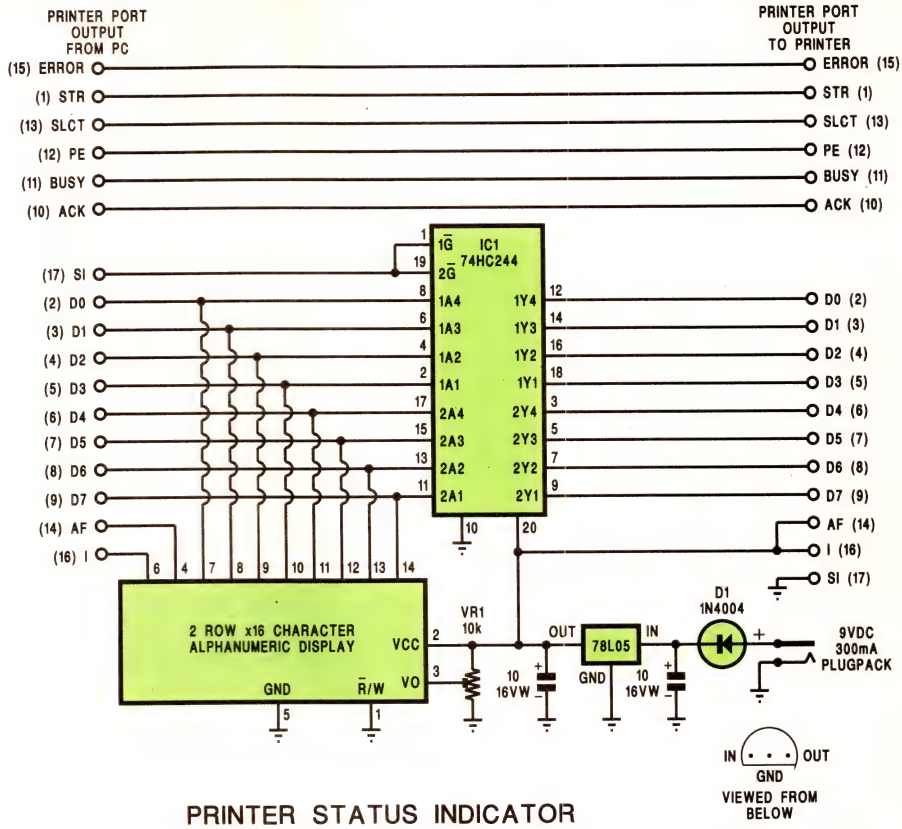
To enable us to run both the printer and the alphanumeric display from the same port, we have to stop the data from port A (data lines D0-D7) that is specifically meant for the display from going to the printer.

This is accomplished by using IC1, the 74HC244 8-way Tri-state buffer. When SI pulls low, the buffers allow data to flow from the PC to the printer but when SI goes high, the outputs of IC1 go into a high-impedance state.

Since IC1 is used to prevent confusion between data for the printer and data for the display, you may wonder how the display can function properly since it has the data lines connected to its inputs at all times. This is OK though because the display does not respond to the data until the AF and I lines are changed appropriately. In effect, pin 6 of the display must go high and then low (it's a negative edge-triggered device) and pin 4 must either be high for data or low for a command (such as "clear display").

Power supply

Power for the Printer Status Indicator comes via a 9V DC 300mA plugpack. Diode D1 provides reverse polarity protection. A 78L05 low-power 5V regulator produces the 5V DC required to drive the display, as well as the two "dummy drive" lines to the printer; ie the AF and I lines to the Centronics port connector. Trimpot VR1 allows you to optimise the contrast of the display to suit your viewing angle.



PRINTER STATUS INDICATOR

Fig.1: the circuit uses Tri-state buffer IC1 to prevent information intended for the alphanumeric display from corrupting the data intended for the printer. The alphanumeric display shows the current printer status & displays error messages under software control.

Software

As mentioned earlier, the Printer Status Indicator is driven via a software program called PRINTER.EXE. You can obtain a copy of this program from SILICON CHIP as set out in the

PARTS LIST

1 PC board, code 07101941, 133 x 84mm
1 zippy case, 158 x 95 x 53mm
1 front panel label, 90 x 131mm
1 9VDC 300mA plugpack
1 DB25 male-to-male cable
2 DB25 PC-mount female sockets
1 2.1mm DC socket
1 16-pin 90-degree pin header
1 10kΩ horizontal 5mm trimpot
2 10µF 16VW electrolytic capacitors
4 10mm x 3mm spacers
2 5mm x 3mm spacers

Semiconductors
1 16x2 row alphanumeric display (Altronics Z-7299; see note)
1 74HC244 Tri-state buffer (IC1)
1 78L05 5V 100mA regulator
1 1N4004 rectifier diode (D1)

Miscellaneous
Tinned copper wire, solder, screws, nuts & washers.

Note: an alternative alphanumeric display panel and matching PC board are available for this project from Oatley Electronics. For details, phone them on (02) 579 4985.

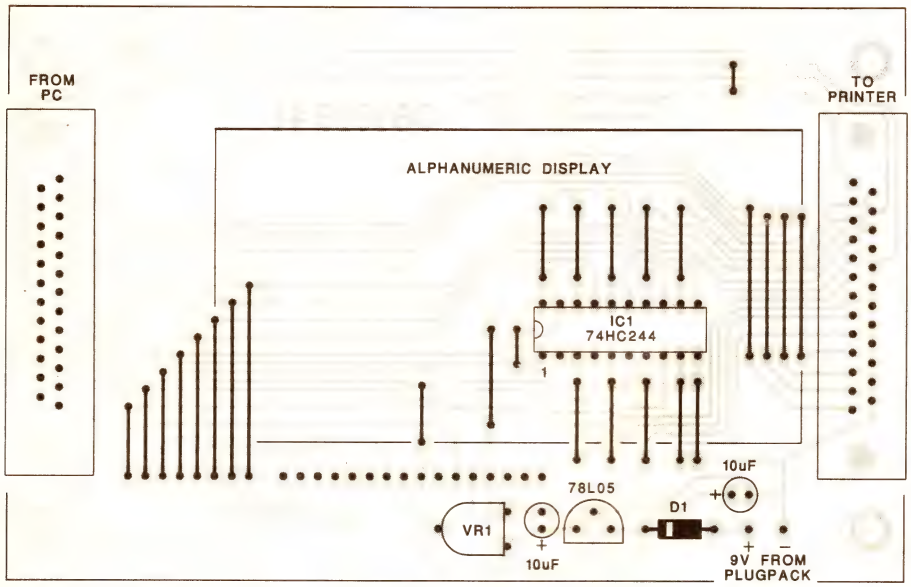


Fig.2: install the wire links on the PC board before mounting the remaining parts. The alphanumeric display is installed by first soldering a right-angle pin header to the underside of the module & then soldering the pin header directly to the PC board.

accompanying panel. We'll be supplying both the EXE file and the source code for this project, so that those of you with the skill and inclination can modify the program to suit an individual need.

In operation, the software drives the alphanumeric display and sends the file byte by byte to the printer. It also provides a continuous on-screen display which shows the current status of the file in terms of the number of kilobytes sent and its status in bargraph form. This can be seen in the screen shots elsewhere in this article.

Briefly, the program checks the printer's status lines after each byte is sent to make sure that no errors have occurred during that transmission. If an error does occur, the printer changes the state of one of these status lines and the program then notifies you, both on-screen and on the LCD, that the error has occurred.

To keep the speed up, the program uses one of the DOS interrupts, INT 21, in a machine-code routine to send each byte of data to the printer.

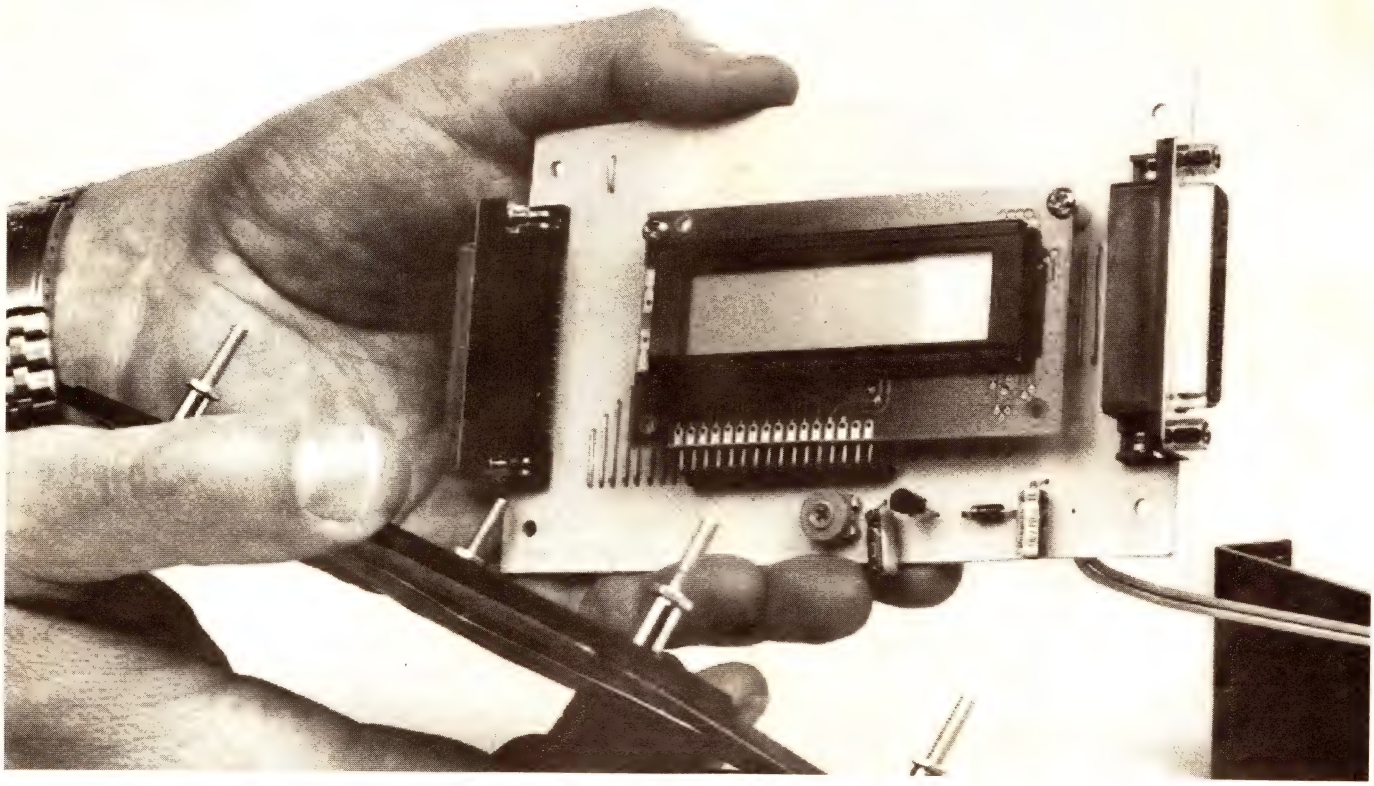
The main benefit of this project is in the remote display. By having this sit next to your printer, you can instantly see when an error occurs and then rectify it.

Construction

The Printer Status Indicator is constructed on a small PC board coded 07101941 and measuring 133 x 84mm. Before you start installing components, check the PC board carefully against the published artwork – see Fig.7. Any defects should be fixed before proceeding further.

You can start the board assembly by installing the wire links. Next up, take the alphanumeric display module and solder the 16-pin right-angle connector to the copper pads on the underside of its board. You should end up

Below: the PC board assembly is secured to the lid of the case on 10mm stand-offs, with an extra nut on each stand-off to provide additional spacing. The trimpot sets the display contrast.



How To Buy The Software

The program PRINTER.EXE and the source code PRINTER.BAS can be obtained by sending $6 plus $3 for postage and packing to SILICON CHIP, PO Box 139, Collaroy, NSW 2097 or by faxing your credit card authorisation to (02) 979 6503. Please nominate your choice of 3.5-inch or 5.25-inch floppy disc to suit IBM compatible computers. We accept credit card authorisations for Bankcard, Visacard and Mastercard.

with a row of pins which will then fit neatly into the associated holes on the main PC board. Don't solder them to the main PC board just yet, though.

The next task is to solder in the IC, followed by the capacitors, the diode, the regulator and the trimpot. After that, you can install the two right-angle DB25 female connectors on the board. Finally, mount the display module in position and secure it at the back using two 5mm spacers plus machine screws, nuts and washers.

Drilling the case

The next major job is to make the necessary cutouts in the specified plastic case which measures 158 x 95 x 53mm. You will need cutouts for the display bezel and for the two DB-25 sockets.

The first step is to use the front panel label as a template to mark the cutout for the alphanumeric display. The easiest way to make this cutout is to first drill a series of small holes around the inside perimeter of the display's outline. The centre piece can then be knocked out and the job filed to a smooth finish. This done, the board can be temporarily positioned on the lid and its four mounting holes marked and drilled.

The next step is to mark the cutouts for the two DB-25 sockets. Note that these cutouts must provide sufficient clearance for the cable connectors. As you can see from the photos, this requires holes to be cut in both the lid and the base. The cutouts in the lid are approximately 58 x 13mm at both ends, while the cutouts in the ends of the base are 58 x 14mm deep.

```
PRINTER STATUS INDICATOR DRIVER          All rights reserved.
(C) Copyright 1993 Silicon Chip          This program may not be copied without
 Written by DARREN YATES B.Sc.           prior consent of the author or publisher.

 File to be sent: AUTOEXEC.BAT
 Size of file   :  383 bytes
 Date of file   : 02-11-93
 Time of making :  1:40p

 Press [c] to start printing
       [q] to quit
```

Fig.4: this is the opening on-screen display when PRINTER.EXE is executed. It gives the name of the file to be printed plus various file details & gives you the option of either printing or quitting back to the DOS prompt.

```
PRINTER STATUS INDICATOR DRIVER          All rights reserved.
(C) Copyright 1993 Silicon Chip          This program may not be copied without
 Written by DARREN YATES B.Sc.           prior consent of the author or publisher.

 File to be sent: AUTOEXEC.BAT
 Size of file   :  383 bytes                    Printing...
 Date of file   : 02-11-93
 Time of making :  1:40p

 Sending file AUTOEXEC.BAT to printer on LPT1:
 Bytes sent:

 OUT OF PAPER: Check the paper supply and printer for problems.
 Make sure the printer cable is connected to your PC correctly.

 OUTPUT ERROR: Check that the printer is ON LINE. The ERROR flag
 has been set, indicating that it cannot accept the file.

 Press [c] to continue file transfer to printer
       [q] to quit.
```

Fig.5: this is the on-screen display that appears if problems are encountered in transferring the file. It suggests possible causes of the problem (eg, printer out of paper, printer cable not connected or printer off-line) & tells you what to check. Pressing 'c' will continue the file transfer to the printer once the problems have been cleared or you can press 'q' to quit.

```
PRINTER STATUS INDICATOR DRIVER          All rights reserved.
(C) Copyright 1993 Silicon Chip          This program may not be copied without
 Written by DARREN YATES B.Sc.           prior consent of the author or publisher.

 File to be sent: AUTOEXEC.BAT
 Size of file   :  383 bytes                    Printing...
 Date of file   : 02-11-93
 Time of making :  1:40p

 Sending file AUTOEXEC.BAT to printer on LPT1:
 Bytes sent:      0.3k

 File AUTOEXEC.BAT sent to printer on LPT1
 Total bytes sent: 383

 Press a key to return to DOS prompt
```

Fig.6: if printing is successful, the on-screen display completes the bargraph at top right & indicates that the file has been sent. Pressing any key then returns you to the DOS prompt.

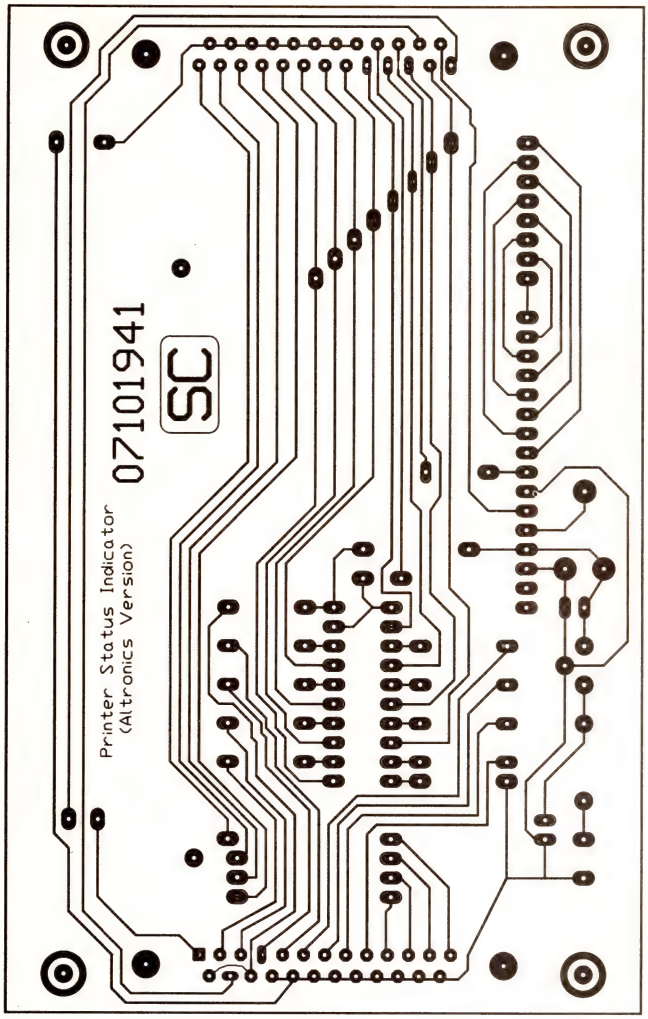


Fig.7: it's a good idea to check your PC board for etching defects by comparing it with this full-size pattern before installing any of the parts. The board is coded 07101941 & measures 133 x 84mm.

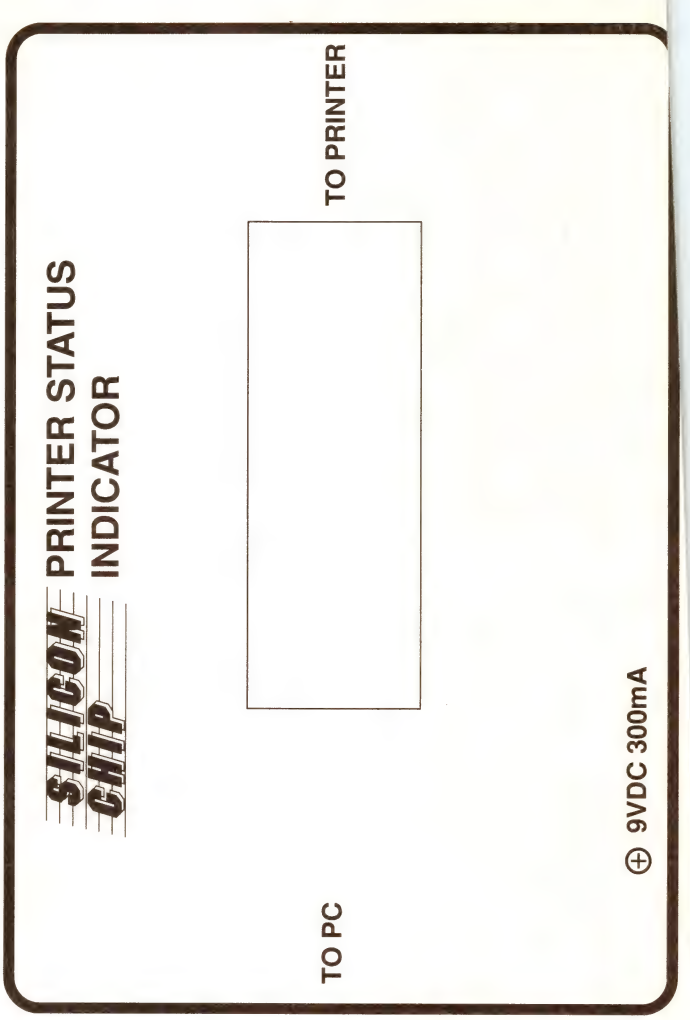


Fig.8: this artwork can be used as a drilling template for the display cutout. The cutout is made by drilling a series of small holes around the inside perimeter & then knocking out the centre piece & filing to a smooth finish.

Finally, you will have to drill a hole in one end of the case for the DC power socket.

Applying power

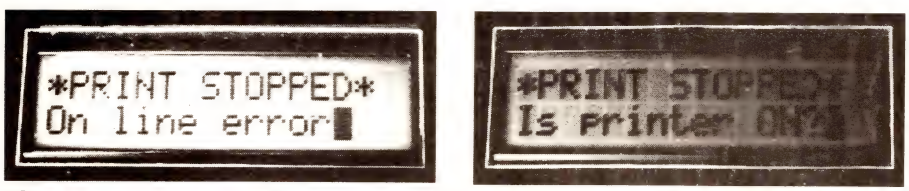
Before the unit is fully assembled into the case, it should be tested and the first step is check its current consumption. To do this, connect your multimeter in series with one of the supply leads (select the 400mA range), apply power and check that the current is less than 10mA. Any more than 20mA and you should switch off and check that you have installed all of the components correctly.

If this is OK, you can hook up your printer and computer to the PC board via two DB25 cables. It is time to test the software and alphanumeric display. Copy the files on the program disc into a directory on your hard disc that's in the path command (or modify your path command to include the relevant directory) and type: PRINTER C:\AUTOEXEC.BAT <return>.

You should obtain a screen display similar to those shown in this article. You are now asked to "Press [c] to start printing". When you do so, the alphanumeric display should now show "Sending file:" on the top line and "AUTOEXEC.BAT_" on the bottom line. At the same time, your printer should also start to operate.

If you've come this far without any problems, then it's safe to say that the unit is working correctly. If the alphanumeric display shows the correct information but the printer isn't working, you should check that IC1 is working correctly and that you've installed it the correct way around.

Finally, bolt the board to the lid and secure the lid to the case. Your Printer Status Indicator is now ready for action. SC



These two photos show the read-out on the alphanumeric display when the printer is off-line & when the printer is switched off, respectively. Other messages are used to indicate that the printer is out of paper or that the file is being sent to the printer.

A-ONE A-ONE A-ONE A-ONE A-ONE

ALL ITEMS REDUCED TO CLEAR LIMITED STOCK ONLY MINIMUM 15% OFF

ITEM No.	KITS	WAS	NOW
K0008	5/20V POWER SUPPLY	17.95	15.60
K0056	MAINS LINE FILTER	37.50	32.60
K0057	240V AUTO POWER RELAY SWITCH	57.50	50.00
K0101	BENCH AMPLIFIER	21.50	18.70
K0102	50MHZ DIGITAL FREQUENCY METER	96.00	72.00
K0103	1GHZ DIGITAL FREQUENCY METER	279.00	199.50
K0105	CAPACITANCE METER ADAPTOR	24.00	20.80
K0108	POWER TRANSISTOR TESTER	24.00	19.20
K0109	TRANSISTOR BETA TESTER	24.50	21.30
K0110	10A DC ELECTRONIC FUSE	38.00	30.40
K0112	MEGGER METER 500V/1000V	77.00	66.95
K0114	LOW COST TEMPERATURE PROBE	21.00	18.00
K0116	ZENER DIODE TESTER	19.00	16.50
K0118	OP AMP FUNCTION GENERATOR	15.95	13.85
K0119	LOGIC PROBE	27.59	24.30
K0120	OSCILLATOR CIRCUIT	12.95	11.20
K0121	LIQUID CRYSTAL THERMOMETER	64.95	56.40
K0122	3-DIGIT PANEL METER WITH ADD-ON COUNTER	36.95	32.10
K0123	INDUCTANCE ADAPTOR FOR DMM	38.50	33.40
K0124	DIGITAL STORAGE CRO ADAPTOR FOR PC	61.50	56.40
K0127	ALPHANUMERIC LCD DISPLAY	38.50	33.50
K0131	50MHZ FREQUENCY COUNTER	87.95	76.50
K01201	HIGH ENERGY IGNITION SYSTEM	57.00	49.50
K0204	LED DIGITAL TACHOMETER	29.50	24.60
K0205	EXPANDED SCALE LED VOLIMETER	16.00	12.80
K0206	LOW VOLTAGE CUT-OUT FOR CARS & BOATS	23.95	20.80
K0207	BASIC CAR ALARM	47.50	41.30
K0208	SCREECHER CAR ALARM	47.50	41.30
K0251	AUTOMATIC CHARGER FOR NiCad BATTERIES	38.00	33.00
K0252	HIGH CAPACITY Ni-Cd FAST CHARGER	124.00	93.00
K0253	SOLAR GENERATOR	13.50	11.70
K0254	12V GELL CELL CHARGER	22.50	19.50
K0255	NiCd DISCHARGER	23.95	20.80
K0256	NiCd DISCHARGER SINGLE CELL	26.95	23.40
K0301	2 SECTOR HOUSE ALARM SYSTEM	87.00	75.50
K0302	INFRARED LIGHT BEAM RELAY	31.50	27.40
K0303	4 DIGIT COMBINATION LOCK	43.50	37.80
K0304	LIGHT ALARM	9.95	8.65
K0306	COMBINATION LOCK	31.95	27.70
K0307	TOUCH SWITCH	13.95	12.10
K0351	LED BARGRAPH DISPLAY	23.00	20.00
K0352	VOICE OPERATED RELAY	21.00	18.00
K0354	2 TUBE OPTION FOR K0353	15.50	13.50
K0355	DISCOLIGHT CHASER & COLOUR ORGAN	153.50	107.45
K0356	SIMPLE 12/24V LIGHT CHASER	38.50	33.40
K0357	LIGHT DIMMER	17.59	15.50
K0358	ELECTRONIC FLASHER	10.95	9.50
K0359	STROBOSCOPIC LIGHT	30.95	26.95
K0360	9V XEONON FLASHER	35.95	31.20
K0361	LED DICE	23.95	20.80
K0362	3.5 DIGIT LCD DISPLAY	33.95	29.50
K0363	QUIZ GAME ADJUCATOR	32.75	28.40
K0401	FM RADIO MICROPHONE	11.00	9.50
K0402	FM STEREO TRANSMITTER	33.95	29.50
K0405	VIDEO ENHANCER	41.00	35.60

ITEM No.	KITS	WAS	NOW
K0406	VIDEO AMPLIFIER	17.00	14.70
K0407	VIDEO TO TV TRANSMITTER	73.00	47.45
K0409	SENSITIVITY SOUND ACTIVATED SWITCH	21.95	19.00
K0413	1-5MIN, MAINS 200-240 TIMER	31.95	27.70
K0414	ELECTRONIC ROULETTE	18.95	16.50
K0415	STAIRWAY TO HEAVEN (REACTION TESTER)	16.95	14.50
K0418	5 AMP DRILL SPEED CONTROLLER	38.50	33.40
K0501	LOW COST 'KARAOKE' ADAPTOR	33.95	29.50
K0502	BABY ROOM MONITOR & FM TRANSMITTER	24.00	20.80
K0503	SPEAKER PROTECTOR MONO	17.00	14.70
K0505	4 INPUT 'DI' BOX FOR STAGE & STUDIO	77.50	67.40
K0506	SUB-WOOFER ADAPTOR	28.00	24.30
K0507	BRIDGE ADAPTOR FOR STEREO AMPLIFIER	14.50	12.60
K0509	SURROUND SOUND PROCESSOR KIT	38.00	33.00
K0510	AUDIO-TO-LIGHT MODULATOR	14.95	13.00
K0511	2 STATION INTERCOM	38.95	33.80
K0512	FIBRE OTPIC AUDIO LINK	79.95	64.00
K0513	SPEAKER PROTECTOR STEREO	33.50	29.00
K0514	WOOFER STOPPER	38.0	50.00
K0552	56 MESSAGE EPROM FOR SPEECH SYNTHESIZER KIT	19.50	19.50
K0553	PC VOICE RECORDER	31.50	27.30
K0602	STEREO 50W+50W MIDI-STYLE AMPLIFIER	287.50	230.00
K0604	20 WATT UTILITY AMPLIFIER MODULE	26.00	22.50
K0607	GENERAL PURPOSE PRE-AMPLIFIER	17.50	15.20
K0608	BALANCED INPUT PRE-AMPLIFIER	19.00	16.50
K0609	4 CHANNEL GUITAR MIXER & PRE AMPLIFIER	47.50	41.50
K0610	120W PUBLIC ADDRESS AMPLIFIER	479.00	360.00
K0612	TDA 7052 IW AMPLIFIER	12.95	11.20
K0615	AUDIO POWER METER	23.95	20.80
	FULLY BUILT FOR LESS THAN KIT COST	**WAS**	**NOW**
00054	COMPACT 12V-240VAC 40W INVERTER	100.00	75.00
00055	12V-240VAC 300W INVERTER WITH AUTO START	399.00	300.00

	RACK MOUNT CASES	WAS	NOW
80301	RACK MOUNT CASE 19" 1U NAT ANOD.	70.00	59.50
B0302	RACK MOUNT CASE 19" 2U NAT ANOD.	84.00	71.40
B0303	RACK MOUNT CASE 19" 3U NAT ANOD.	93.00	79.05
B0304	RACK MOUNT CASE 19" 1U BLACK ANOD.	70.00	59.50
B0305	RACK MOUNT CASE 19" 2U BLACK ANOD.	84.00	71.40
B0306	RACK MOUNT FASE 19" 3U BLACK ANOD.	93.00	79.05
B0307	RASE CASE - 3U AL FRONT PANEL	123.00	104.55
B0308	4U-10" RACK CASE	45.00	38.25
B0310	4U-12" RACK CASE	52.00	44.20
B0311	3U-14" RACK CASE	56.00	47.60
B0312	4U-14" RACK CASE	65.00	55.25
B0313	2U-12" ALUMINIUM RACK CASE	82.00	69.70
B0314	3U-14" ALUMINIUM RACK CASE	92.00	78.20
B0315	RU-12" ALUMINIUM RACK CASE	92.00	78.20
B0316	2U-10" ALUMINIUM RACK CASE	72.00	6.20
B0317	3U-10" ALUMINIUM RACK CASE	77.00	65.45
B0318	4U-10" ALUMINIUM RACK CASE	82.00	69.70

	RACK FRAMES	WAS	NOW
B0402	RACK FRAME 6U BLACK (370MM)	139.00	118.15
B0404	RACK FRAME 30U BLACK (1450MM)	215.00	182.75
B0405	RACK FRAME 18U (900MM) BLACK	179.00	152.15

ITEM No.	RACK FRAMES	WAS	NOW
B0406	PANEL SET FOR B0405	102.50	87.13
B0407	RACK PANEL FOR B0404	149.00	126.65
B0408	RACK PANEL FOR B0413	47.50	40.38
B0409	PANEL SET FOR B0402	52.95	45.01
B0410	RACK SHELF 2U	47.95	40.76
B0411	RACK FRAME 12U (630MM) BLACK	159.00	135.15
B0412	PANEL SET FOR B0410	87.50	74.38
B0413	RACK FRAME 47 (280MM) BLACK	35.00	114.75
B0414	RACK SHELF 3-UNIT	47.95	40.76
B0415	RACK SHELF 4-UNIT	52.95	45.01
B0416	2U UNIVERSAL FRONT PANEL	13.50	11.48
B0417	3U UNIVERSAL FRONT PANEL	16.50	14.03
B0418	4U UNIVERSAL FRONT PANEL	18.50	15.73
B0501	2U-CABINET HANDLE	6.50	5.53
B0502	3U-CABINET HANDLE	7.50	6.38
B0503	4U-CABINET HANDLE	8.50	7.23

	ELECTROLYTIC CAPACITORS	WAS	NOW
E0001	4000uF,63V,CHASSIS MOUNT WITH CLIP	9.00	7.65
E0002	4000uF,75V,CHASSIS MOUNT WITH CLIP	14.00	11.90
E0003	8000uF, 63V,CHASSIS MOUNT WITH CLIP	14.00	11.90
E0004	8000uF, 75V, CHASSIS MOUNT WITH CLIP	23.50	19.98
E0005	10000uF, 50V, CHASSIS MOUNT WITH CLIP	16.00	13.60
E0006	10000uF, 100V, CHASSIS MOUNT WITH CLIP	24.00	20.40
E0007	16000uF, 50V, ELECTROLYTIC CAN CAPACITOR	34.95	29.71
E0008	1800uF, 50V, ELECTROLYTIC CAN CAPACITOR	29.95	25.46
E0009	9900uF, 50V, ELECTROLYTIC CAN CAPACITOR	50.00	42.50

	HEAT SINK	WAS	NOW
E0601	HEAT SINK T03 UNIVERSAL 'U'	1.03	1.11
E0602	HEAT SINK MINI 'U'	.90	.77
E0603	HEAT SINK T0220 CLIP ON	0.75	0.64
E0604	HEAT SINK THERMALLY T03	1.30	1.11
E0605	HEAT SINK T03 MINI	2.75	2.34
E0606	HEAT SINK EXTRA HEAVY DUTY 125X100	10.95	9.31
E0607	HEAT SINK EXTRA HEAVY DUTY 125X125	11.95	10.16
E0608	HEAT SINK MINI V-TO-220	0.70	0.60
30609	HEAT SINK T0220 PCB 15X20MM	0.80	0.68
E0610	HEAT SINK HEAVY DUTY 72X110X33	6.50	5.53
E0611	HEAT SINK HEAVY DUTY 72X110X33 2-T03	8.95	7.61
E0612	HEAT SINK MEDIUM DUTY 72X102X25	5.95	5.06
E0613	HEAT SINK MEDIUM DUTY 72X102X25 2-T03	6.95	5.91
E0614	HEAT SINK EXT DUTY 125X75	8.95	7.61
E0615	HEAT SINK T0220 PCB 10X20MM	0.70	0.60
E0616	HEAT SINK HEAVY DUTY TOP3 PC8 34X50	1.50	1.28
E0617	HEAT SINK EXTRA HEAVY DUTY 125X250	22.95	19.51
E0618	HEAT SINK EXTRA HEAVY DUTY 125X300	24.95	21.21
E0619	HEAVY DUTY HEAT SINK 100X110X33	8.95	7.61
E0701	HEAT SINK COMPOUND TUBE UNIC	3.00	2.55
E0702	HEAT SINK COMPOUND 150G TUBE	21.00	17.85
E0703	HEAT SINK COMPOUND SYRINGE 50G	9.50	8.08

	FAN	WAS	NOW
F0001	80MM, 240VAC, 14W COOLING FAN	21.50	18.28
F0002	120MM, 240VAC, 20W COOLING FAN	22.50	19.13
F0003	80MM, 12VDC, 1.6M, COMPUTER TYPE FAN	16.50	14.03
F0004	120MM, 24FDC, 6W, COMPUTER TYPE FAN	22.00	18.70
F0005	FINGER GUARD FOR 80MM FAN ALL METAL	2.20	1.87
F0006	FINGER GUARD FOR 120MM FAN ALL METAL	2.20	1.87

A-ONE

ELECTRONICS PTY LTD

432-434 Kent Street,
Sydney NSW 2000
Phone (02) 267 4819
Fax: (02) 267 4821
A.C.N. 003 882 513

MAIL ORDERS WELCOME:

CHEQUE, MONEY ORDER, AMERICAN EXPRESS, BANKCARD, MASTERCARD AND VISA.

POSTAL CHARGE

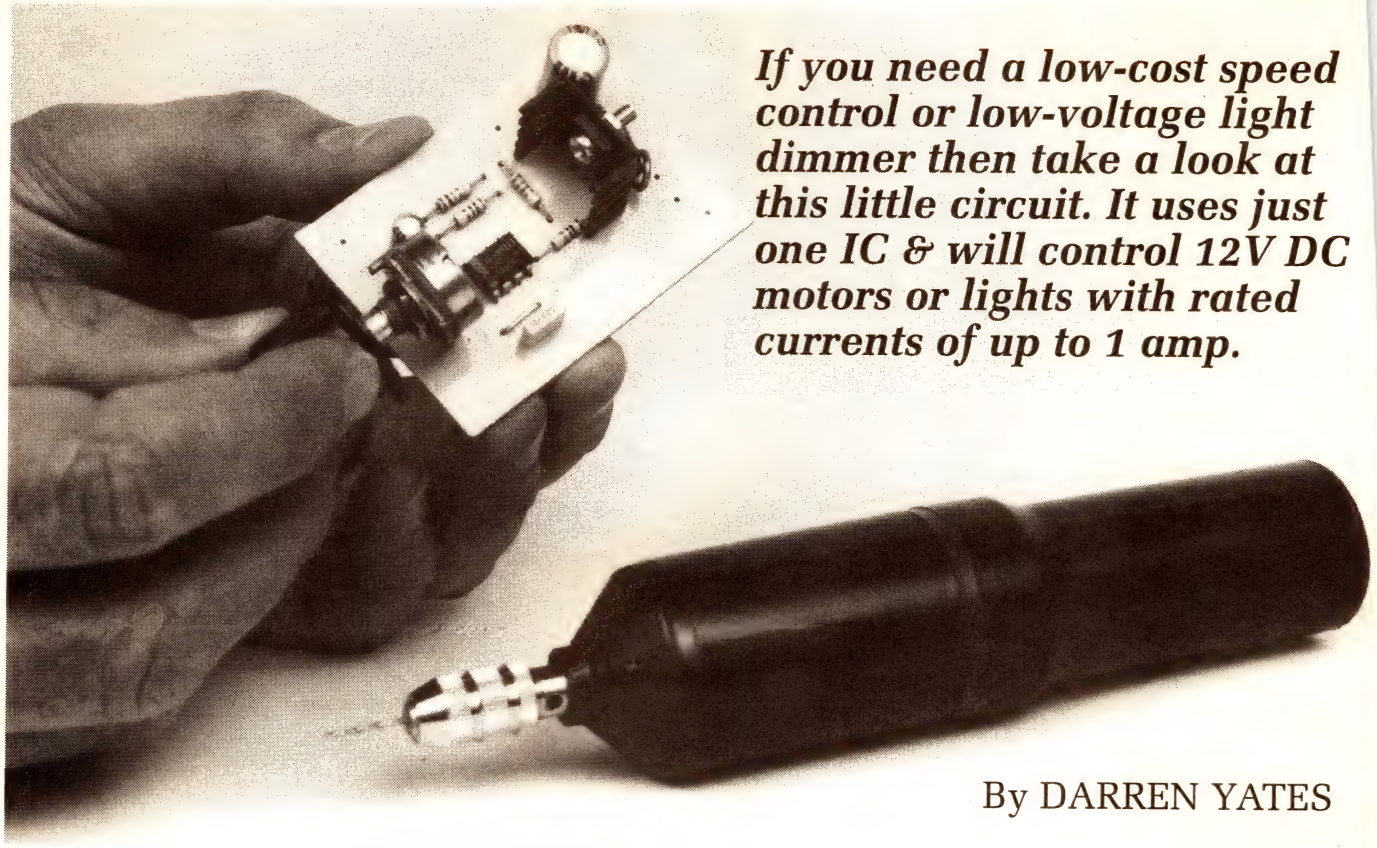
$5-25.....$4.50 $51-100.....$7.00

$26-50.....$5.50 Over $100 .....$10.00

SPECIAL PRICE FOR RACK FRAMES

Phone or write to us for a coy of your price list. Shop hours Mon-Fri 9-6. Sat 9-4. All prices include sales tax

A-ONE A-ONE A-ONE A-ONE A-ONE



If you need a low-cost speed control or low-voltage light dimmer then take a look at this little circuit. It uses just one IC & will control 12V DC motors or lights with rated currents of up to 1 amp.

By DARREN YATES

A simple low-voltage speed controller

If you make your own PC boards, then no doubt you own one of those small PC board drills. These call for an external 12V DC supply capable of delivering at least 1A. With a supply of this rating, the drill will run at about 10,000RPM. However, you don't always want to run the drill at full speed and so ideally you need a variable power supply.

This simple circuit will do the job efficiently and at low cost. It uses only a handful of components and will comfortably control DC motors rated up to 1A. It is a switching circuit which delivers bursts of current to the motor to provide an efficient means of varying the speed.

The circuit can also be used to dim 12V lights and, in fact, its principle of operation is the same as used in the dimmers for automotive dashboard lamps.

Circuit diagram

As you can see in Fig.1, the Mini Drill Speed Controller uses very few components and only one IC – a CMOS 555 timer. The 10kΩ and 5.6kΩ resistors, along with the 0.1μF capacitor at pins 2 and 6, set the output frequency of the 555 to about 6.8kHz, although this will vary according to the speed setting. The duty cycle of the pulse output at pin 3 is set by VR1 which has its wiper connected to the control input (pin 5).

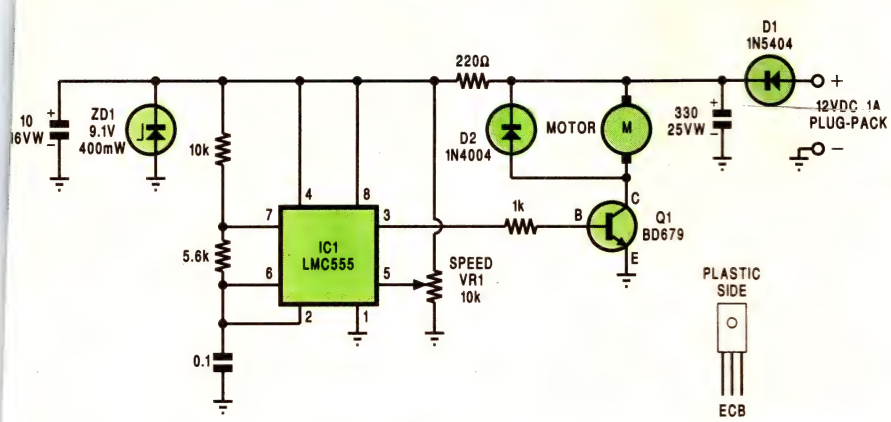
The higher the control voltage to pin 5 of IC1, the higher the duty cycle and visa versa. The output signal is taken from pin 3 and drives Darlington transistor Q1 via a 1kΩ resistor. Q1 in turn drives the drill motor while diode D2 prevents Q1 from being damaged due to the back-EMF generated each time the motor switches off.

The voltage supply to the 555 IC is regulated to 9.1V by zener diode ZD1 and its associated a 220Ω limiting resistor. While the 555 is fairly tolerant of supply variations, the zener diode and its accompanying 10μF filter capacitor are desirable to filter out hash and spikes which can be generated by the motor's commutator.

A 330μF capacitor at the supply input provides extra filtering, while diode D1 protects the circuit against incorrect supply polarity.

Construction

All of the components for the Mini Drill Speed Controller are installed



MINI PCB DRILL SPEED CONTROLLER

Fig.1: the circuit uses 7555 timer IC1 to drive transistor Q1 & this pulses the motor on & off at a frequency of about 6.8kHz. VR1 controls the width of the output pulses on pin 3 of IC1 to set the speed of the motor. The circuit can control 12V DC motors rated up to 1A.

PARTS LIST

1 PC board, code 09111931, 61 x 43mm
1 miniature TO-126/220 heatsink
1 10kΩ 16mm potentiometer (VR1)

Semiconductors

1 LMC555/7555 CMOS timer (IC1)
1 BD679 NPN Darlington transistor (Q1)
1 1N5404 3A diode (D1)
1 1N4004 rectifier diode (D2)
1 9.1V 400mW zener diode (ZD1)

Capacitors

1 330µF 25VW PC electrolytic
1 10µF 16VW PC electrolytic
1 0.1µF 63VW MKT polyester

Resistors (0.25W, 1%)

1 10kΩ 1 1kΩ
1 5.6kΩ 1 220Ω

on a small PC board measuring 61 x 43mm and coded 09111931. Before you begin any assembly work, check the board carefully for any shorts or breaks in the tracks by comparing it with Fig.3. If you do find any faults, fix them before proceeding further.

Once the board has been checked, you can begin construction by installing the wire link, followed by the resistors, the diodes, capacitors and the IC. Follow the overlay wiring diagram to make sure that they are correctly located – see Fig.2.

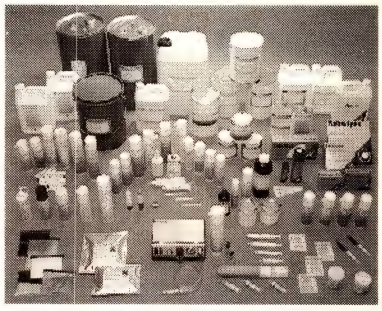
The transistor needs to be fitted with a small heatsink. The 10kΩ pot is a miniature 16mm type which solders directly to the board. If you prefer, you can use one of the larger types with some flying leads to the lid of a box for easier control.

Before you hook up your 12V motor or lamp, apply power to the circuit and measure the current drain with your multimeter switched to amps. When switched on and with no load connected, the circuit should consume about 15mA or so.

If this is OK, connected up a small 12VDC motor or lamp and adjust the control. You should see the motor speed or globe brightness vary as you turn the pot.

The choice of case for the project is left up to you. You could install it inside a small zippy case or diecast box. **SC**

D & K WILSON ELECTRONICS



Have you found those components yet?
We know that it can be difficult, frustrating and a waste of your valuable time.
So why haven't you contacted us?
We specialise in hunting down and locating components – old, obsolete, leading edge, normally available but now scarce due to allocation by overseas manufacturers.
Integrated circuits, resistors, capacitors, transistors, diodes, valves, varistors, etc.
Any brands
Let us save your valuable time
Contact us now on 833 1342
We are also distributors for Electrolube - lubricants and chemicals
Hakko - desoldering & soldering irons; SMD tools; replacement parts
NTE - replacements semiconductors

2/87a Queen St, St Marys, NSW 2760.
Phone (02) 833 1342 Fax (02) 673 4212

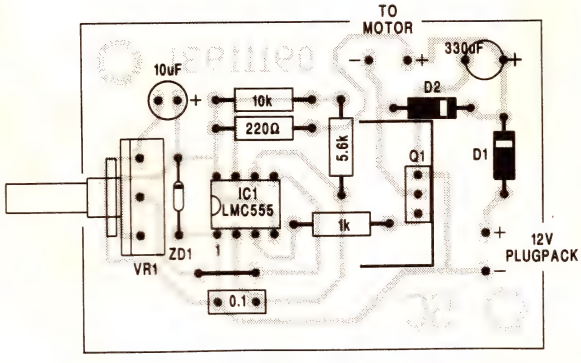


Fig.2: install the parts on the PC board exactly as shown in this layout diagram.

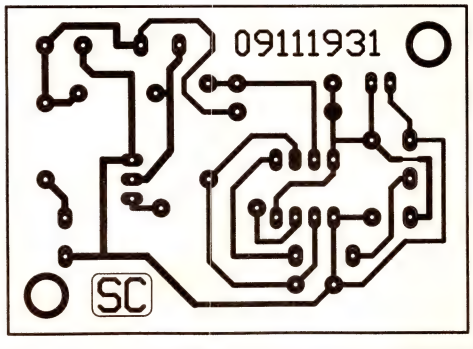


Fig.3: check your PC board against this full-size pattern before mounting any parts.

VINTAGE RADIO

By JOHN HILL

Realism Realized – the Precedent console receiver

A great deal of patience is sometimes needed if one is to restore an old radio to its former glory. My 1932 Precedent console was just one such set.

This story started about five years ago in a junk shop in Castlemaine, Victoria. There it was in all its faded glory – a rather sad looking "Precedent" console radio cabinet with turned legs. The dial escutcheon bore the motto "Realism Realized".

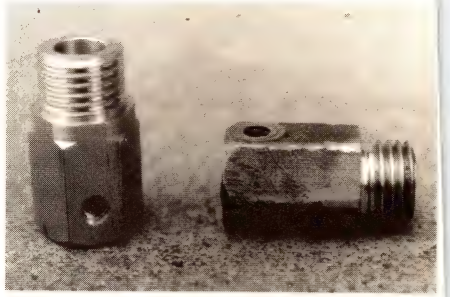
Unfortunately, that's all there was – it was just an empty cabinet and it was not in very good condition either. It had been wet many times and was quite shabby looking in appearance.

However, those of us who collect old radios can picture in our mind's eye what these wrecks looked like when they were new and, more importantly, what they can look like again when restored. As the old cabinet had fair prospects, I offered half the asking price and it was mine.

No innards

From that time on, the cabinet took up residence in my shed and nothing was done to it for the simple reason that there were no innards to put in it. I also realised that, because of its poor condition, the woodwork would require more professional refurbishing than I was able to give it.

The Precedent's dial escutcheon bears the motto "Realism Realized". It is a typical half-moon dial from the early 1930s.



This home-made bearing (left) solved a troublesome dial problem. It was turned up on a metal-cutting lathe in the author's workshop.

Let's face it: we can't be good at everything and restoring dilapidated old radio cabinets is not my strongest point.

To cut a long story short, I was able to locate a complete Precedent (a legless console) with the same dial and control positions. It took a few months to talk the owner into selling it but eventually I became the proud owner. Naturally, my intention was to fit the innards of the legless console into the old turned leg cabinet. I also hoped that I would be able to sort out the mess under the chassis for there appeared to be many modifications to the original circuit.

Incidentally, dates pencilled onto the underside of the chassis indicate that the set was made in October 1932. So we are talking about a 60-year old radio: one of those classics from the early 1930s.

The background

We are going to do a bit of side tracking now but it is all part of the Precedent story.

A friend by the name of Peter Hutton visits me occasionally and as Peter is a fellow radio collector, we have some rather lengthy conversations when he calls. Peter is more than a vintage

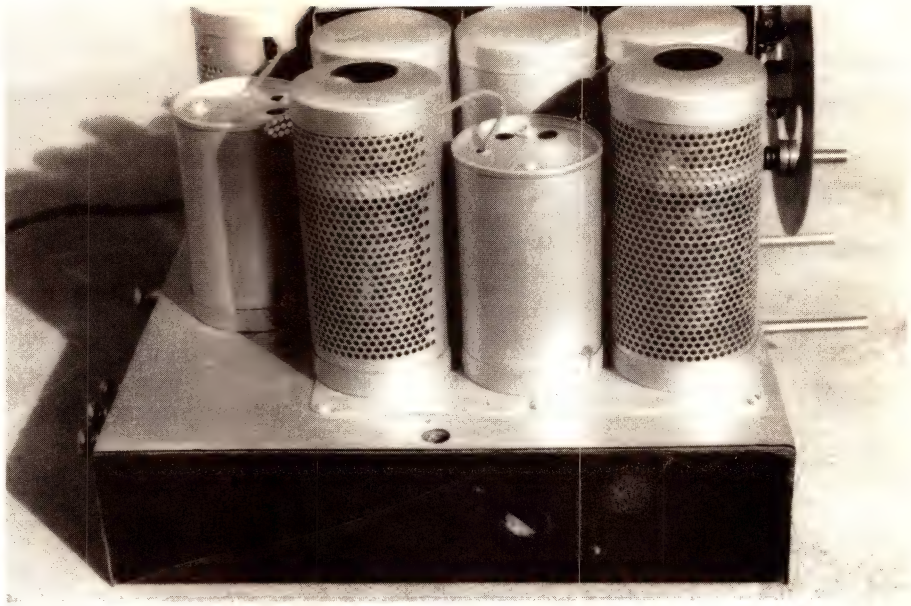
dio enthusiast; he also runs a TV id video repair service and is a co-wner, with his brother David, of the lelbourne Wireless and Sound Mu-eum at Peninsula Boulevard, Seaford, ictoria.

One of the reasons Peter visits me is o see if I have anything interesting for ale and it's not often that he goes way empty handed. He also offers a easonable price for anything he wants - not like some collectors I know!

On his last visit, I decided that it nust be about time the money flowed he other way for a change, so I let him ake away the old Precedent cabinet or restoration. Peter does refurbish-ng work and that old weather-beaten abinet needed his professional touch. Among other things, the top of the abinet required re-veneering, a rather specialised job to say the least.

Apart from cabinet restoration work, The Wireless and Sound Museum offers a wide range of services to the vintage radio enthusiast, all of which are carried out on the premises. I will go into that aspect some other time.

When the Precedent cabinet was returned, I was very pleased with the job. Looking closely, one can see that the original surface was a bit rough and weathered but the overall refurbishing is as good as could have been done considering the condition of the woodwork. It really did require the magic wand treatment and the old cabinet has responded well to many hours of diligent work.



The "U" section chassis of the old Precedent was fitted with timber ends. Although the resulting set-up was not very rigid, such construction techniques helped keep production costs down – an important consideration in 1932!

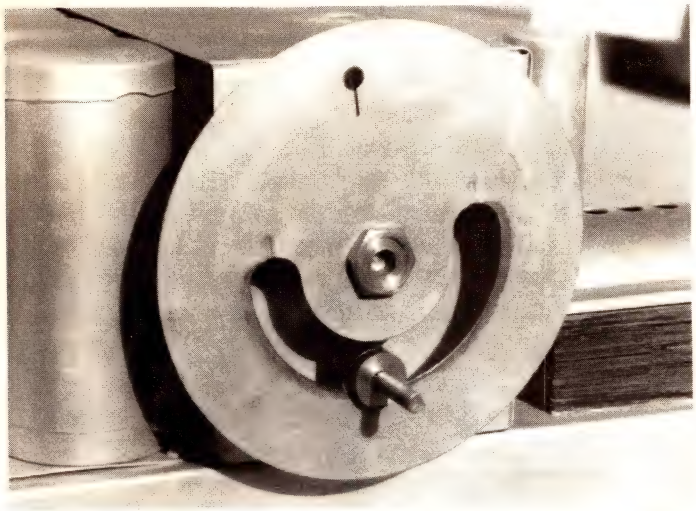
The restoration of the receiver itself was also far from simple and it needed considerably more time than is usually required.

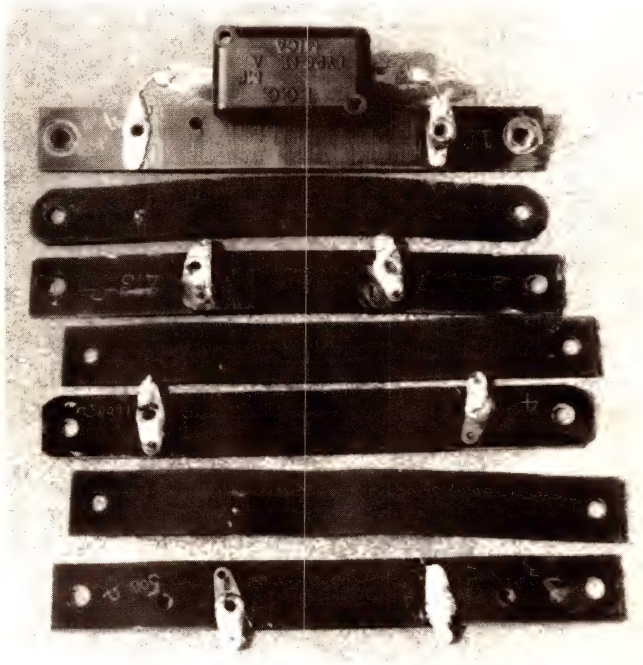
Perished rubber

One of the biggest problems was the perished natural rubber-covered wiring that was used extensively throughout the set. This insulation had broken away in many places, particularly where the wiring went through small holes in the coil cans, IF transformer cans and the chassis. All these leads had to be replaced in order to prevent short circuits and potentially dangerous situations.

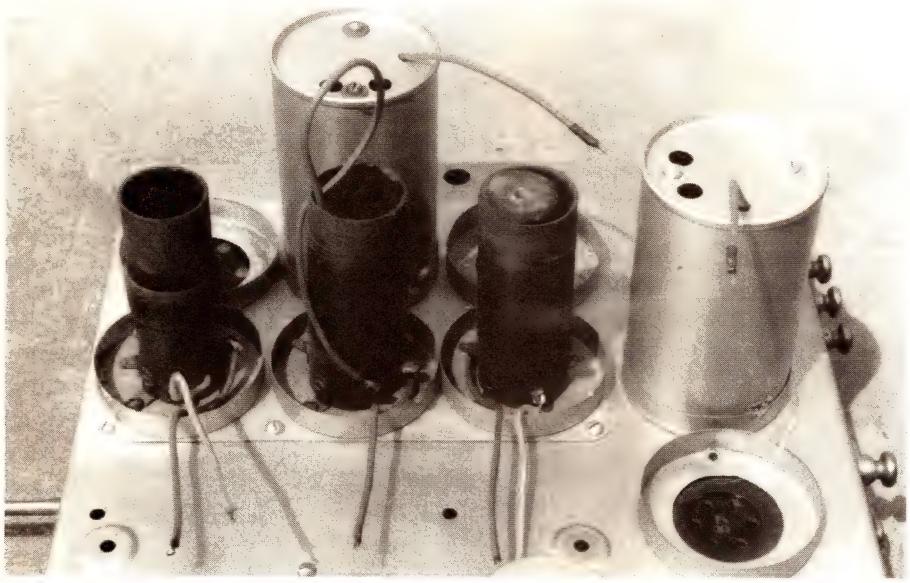
Considerable care must be taken when doing rewiring of this nature to make sure that everything goes back the way it was. Just one connection in the wrong place can cause a lot of trouble and inconvenience. Replacing one wire at a time is a good policy in this situation.

One of the IF transformers had an open winding which was easily located. Green corrosion highlighted the trouble spot in one of the fine leads and it was repaired by bridging the





Above: this close-up view shows the friction dial set-up. The small hole & its associated slit at the top of the disc allows light to shine through and illuminate the dial. At right is the dismantled resistor stack. These wirewound resistors are mounted one on top of the other, with insulating strips between them.



At least half of the original wiring had to be replaced because of perished insulation. The aerial, oscillator and bandpass coils all needed rewiring.

gap with a piece of fuse wire. These old IF transformers were wound using single-strand copper wire on wooden bobbins. Litz wire had not come into general use in 1932.

Valve line-up

The Precedent's valve complement was relatively common for that era and consisted of an 80 rectifier, 57 autodyne mixer, 58 IF amplifier, 57 detector and first audio, and a 47 output. The 47 output pentode is one of the few early AC valves that had a directly heated cathode.

Many readers would know simply by the valves used that the old Precedent was an autodyne superhet with anode bend detection and no automatic gain control. This type of receiver was fairly standard in the early 1930s. However, the Precedent had a few oddities about it that were different to the norm. One of these peculiarities is the "resistor stack".

All the wirewound resistors in the set are wound on flat fibre formers with a solder tag at each end. These strip resistors are drilled at the ends and are mounted one on top of the other in a stack. There are four such wirewound resistors and they are separated from each other by an insulated strip. One of the photographs shows a dismantled resistor stack.

This resistor stack caused just one of the many problems encountered with the restoration, as one of them had gone open circuit. Fortunately, the break was at one end of the winding and was easily repaired by reconnecting it to the solder tag.

When restoring a receiver of th nature, it is advisable to measure ar label such resistances. A known r sistance is easier to replace than a unknown one should it break down some time in the future.

Another oddity was the 2µF pape capacitor that is used as a cathod bypass on the output valve. Normall a low voltage electrolytic type is use in this situation.

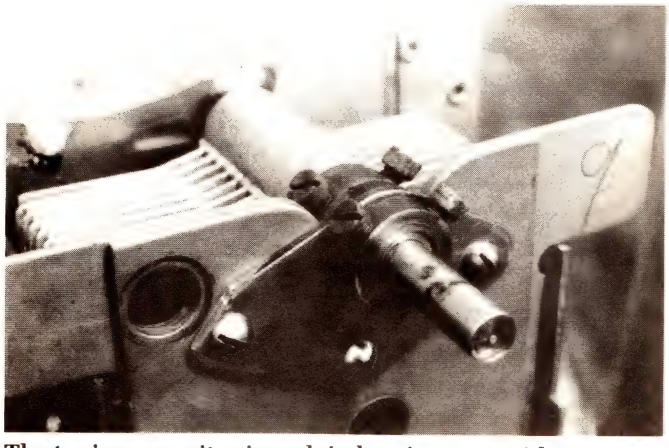
However, one must remember tha this set was built way back in 193 when "dry" electrolytics were in thei infancy. Although they could hav been around at the time, they may no have been reliable units – hence the large paper bypass capacitor.

Dial problems

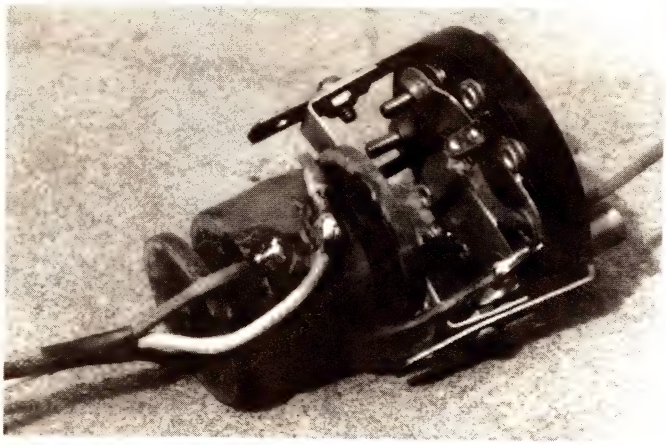
Another problem was the friction drive dial mechanism. Although the drive had plenty of friction, the bearing that the control shaft turned in was very worn and allowed the control shaft to lift. This movement was sufficient to let the friction drive parts come out of engagement and lock up the works.

Having a metal cutting lathe in my workshop helps to solve many worn dial problems and this occasion was no exception. A new bearing was turned up in hexagon brass (see photograph) and the dial drive now functions as it was meant to. Without the lathe, worn dial parts could present some really nasty problems that would be difficult to overcome.

All the old paper capacitors, including the 2µF unit mentioned ear-



The tuning capacitor is a plain bearing type with two collars & set screws to control end float. Plain bearing tuners often require cleaning & lubrication if they are to work smoothly.



The IF transformers required rewiring due to damaged insulation on the original wiring, particularly where this wiring passed through holes in the cans. All leads were replaced to prevent short circuits.

This view shows the 80 rectifier valve (left) & the 47 output valve. The chassis cleaned up quite well for a 60-year old receiver. The two terminals at bottom right are for a gramophone pick-up.

lier, were replaced with modern equivalents. Likewise, the original chassis-mounted high-tension filter electrolytics. These were replaced with new 10µF 450V units.

Another capacitor that needed attention was the tuning capacitor, an old 3-gang type with plain bearings. It was in really good condition for its age and only required cleaning and lubricating. The thrust bearings were also adjusted to prevent end float and to prevent the plates from touching each other.

As luck would have it, there were no problems with the old loudspeaker. The cone was OK, as were the field coil and the output transformer. It's not unusual to strike trouble here, as open circuit field coils are a common problem.

Worth the effort

Now that the Precedent is back together and working again it looks rather good and was well worth the effort and expense. In reality, however, its performance is no better or worse than any other 5-valve autodyne receiver from the early 1930s. All these sets seem to have a slight amount of distortion (due to the anode bend detection) but most people would be unaware of this minor fault. By transistor radio standards, it sounds magnificent!

Although some vintage radio collectors can boast about the beautiful original receivers in their collections, most of us have to make do by scrounging for what leftovers are still around today. Even so, by using skilful repair techniques, enlisting the services of experts and combining the best parts of several radios into one, the end result can be very pleasing. I believe my 1932 Precedent to be one such receiver.

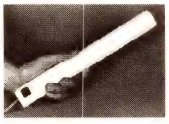
The Precedent may not really be "Realism Realized" by today's standards but in 1932 it may well have been very close to it! SC

This view shows the finished receiver in its refurbished cabinet. It's quite a stylish outfit if you happen to like old console radios.

AUSTRALIAN MADE TEST EQUIPMENT
12 MONTHS WARRANTY ON PARTS & LABOUR
PRODUCTS YOU NEED
THAT MAKE LIFE EASIER

SHORTED TURNS TESTER

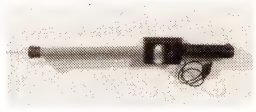
Built-in meter to check EHT transformers, including split diode type, yokes and drive transformers.
$95.00 + $3.00 p&p



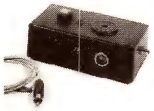
DEGAUSSING WAND

Great for computer monitors. Strong magnetic field. Double insulated, momentary switch operation. Demagnetises colour picture tubes, colour computer monitors, poker machines video and audio tapes. 240V AC 2.2 amps, 7700AT.
$85.00 + $10.00 p&p

HIGH VOLTAGE PROBE



Built-in meter reads positive or negative 0-50kV. For checking EHT & focus as well as many other high tension voltages. **$120.00 + $5.00 p&p**



REMOTE CONTROL TESTER

Designed to test infrared or ultrasonic remote control handpieces; eg, for TVs, VCRs, house alarms and car alarms. Supplied with extension infrared detector lead. Output is via a LED and piezo speaker.
$97.00 + $4.00 p&p.

SILICON CHIP COLOUR TV PATTERN GENERATOR

Built-up kit comes with power plugpack, RF lead. **$250.00 + $9.00 p&p.**

TV & VCR (new) tuners – $47.00 each
VCR converters – $49.00each

TV, VCR
TUNER REPAIRS
FROM $22
REPAIR OR EXCHANGE

J.V. TUNERS
Phone for free product list
216 Canterbury Rd, Revesby, NSW 2212, Australia.
Phone (02) 774 1154 Fax (02) 774 1154
Cheque, Money Order, Visa, Bankcard or Mastercard

SERVICEMAN'S LOG

It was all a long time ago

I have two quite unusual stories this month. For how long & by what devious means can one keep a TV set working? And for how long should one keep customers' records? The other story emphasises how lost we can feel when away from our own workbench.

The first story really started over 11 years ago. It was little more than a routine job then and I certainly did not imagine that I would be resurrecting it after all this time. But I did make notes about it; not only in the normal way for my own benefit but also for a colleague who expressed some interest in it. So I was able to recall the events in reasonable detail.

It was all brought back by a recent phone call. A lady at the other end of the line introduced herself – the name didn't register immediately – and went on to remind me that I had fixed her TV set, an HMV, "some time ago", and that it involved a problem with the green in the picture.

My memory isn't particularly good on some-time-ago jobs (one handles so many jobs) but the mention of the green problem rang a bell. I asked her if she was living at a particular address at the time – it's funny the way one's memory works at times.

Yes, that was correct. And the whole story came flooding back. In particular, I remembered how accurately she had described the symptoms; far more so than most people. And I also registered that it was more than some time ago; it was long time ago. In fact, I ha begun to link it with other events an was thinking in terms of six or eigh years, which wasn't that far out.

But despite the fact that I remem bered the set and its symptoms, I coul not recall the fault itself or what I ha done to fix it. Anyway, I regarded al that as being of little importance an asked what problem she had now. T my surprise, she replied that the HMV set was the problem.

Was that set still going after all these years? Yes, it was but, on her own admission, apparently not very well. Her son, who works for the ABC in another state, had visited her recently and commented that the picture – and particularly the colour – was rather poor. In short, he realised that gradual picture deterioration had crept up on

Light

A **SADELTA TC400** signal level meter will shed light on all your antenna work. $599. +20% Sales Tax

Peter C. Lacey Services Pty. Ltd.
80 Dandenong Rd. FRANKSTON 3199
Tel:(03) 783 2388 Fax:(03) 783 5767 ACN006893438

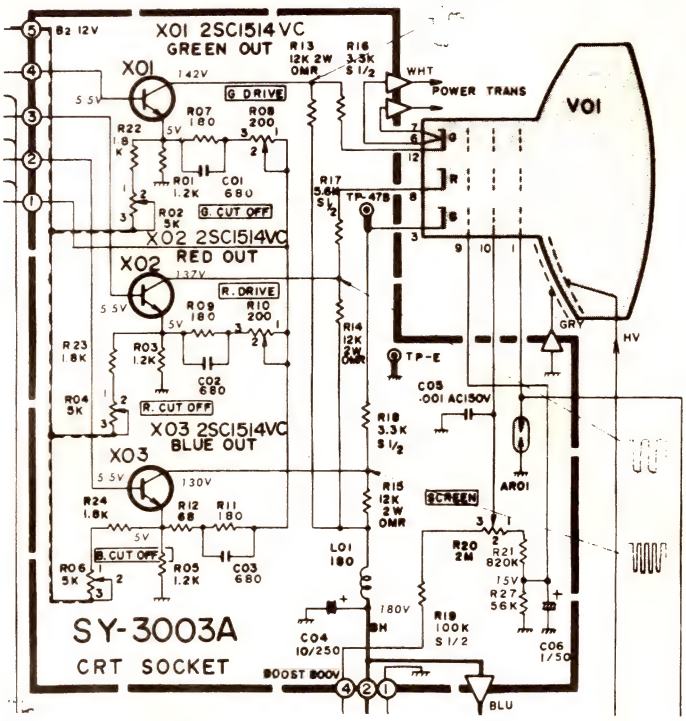


Fig.1: the RGB driver stage in the HMV 12642. The green driver stage, X01, is at the top of the diagram & is direct coupled to the green gun cathode. Doctoring this stage restored performance.

I ASKED HER IF SHE WAS LIVING AT A PARTICULAR ADDRESS AT THE TIME ~IT WAS A LONG TIME AGO...

her over the years and suggested that it was time she bought a new set.

And that was the purpose of the call; not to initiate any service to the set but to seek my advice regarding a new set. In particular, she needed to know which brands I handled on a warranty basis because she wanted to be sure I would be available to service the set. Such loyalty can be quite touching at times.

So that was more or less it. I nominated the brands I handle on a warranty basis and left it to her to choose which ever one she fancied. She thanked me and we left it at that.

How long ago was it?

And that should have been the end of it. But I couldn't get the set out of my mind. Just how long ago was it? So I began searching through my old files. It turned out to be quite a search but I eventually found the relevant file and a copy of the invoice, dated September 1st, 1982 – over 11 years ago at the time of writing. But that wasn't the real surprise; that was only appreciated when I read my notes about the fault and its cure.

The set was a 48cm HMV, model 12642 (which was also marketed as a JVC 7765AU), and it was about five years old at the time. The fault, as described by the customer, was that the picture had lost its green content. And I had noted that this customer was more astute than most; her description was completely accurate.

In greater detail, she explained how the set had turned on a display of multi-coloured fireworks on the screen. This display lasted for a few seconds and the set then behaved normally; except that there was no green.

As recounted in my notes, there was initially some confusion on my part as to the exact cause. At first I suspected some kind of green gun failure but, in fact, I found I was able to produce a green image using various brute force tactics.

This led me to suspect a circuit fault, whereby the tube was not receiving adequate green signals, and I spent some time following this lead, only to finally conclude that it was false; that the fault had to be in the tube. More specifically, I concluded that the fireworks display had been caused by a fragment – probably loose cathode material – causing a momentary internal short. And this had damaged the green cathode, reducing it's emission to the point where it was virtually cut off at the normal bias level.

So was it worthwhile fitting a new tube or was the set a write-off? It was a marginal situation and the lady was not very happy about spending a couple of hundred dollars on a replacement tube, much less the cost of a new set.

Finally, I decided to take a punt on a mild form of butchery. As matters stood, the tube and – potentially – the set were both a write off. But suppose I were to doctor the bias voltage; could I brute force the green back to a normal level? And, if so, how long would such a trick last?

The first question was easily answered. Reference to the circuit (see Fig.1) shows that the collector of the green driver transistor (X01) is directly coupled to the green gun cathode and sets it at about 142V. By shunting R01, a 1.2kΩ resistor in the emitter circuit of X01, the current through X01 would be increased, its collector voltage reduced, and the bias on the green gun reduced. And it worked. After some trial and error, I settled for a 5.6kΩ resistor across R01, which produced virtually normal green performance.

The second question was another matter. I had no way of knowing how long it would last but I reckoned a minimum of 12 months would be a reasonable guess. Anything after that would be cream on the custard. And so, on that basis, I felt that this approach was justified. It would give the customer time to assess her financial situation and decide on a new tube or a new set.

I was most careful to explain what I had done; that it was a short-term measure that could only be justified on a nothing-to-lose basis. Assuming she was happy, I would leave it like that. She said she was and so I did.

As I recall, I checked the situation about a year later and the set was still going strong. And that was the last I heard of it – until now. But another 10 years? That's a lot of cream!

Curiosity killed the ...

Having sorted out all those memories, another thought occurred to me. Would the lady let me borrow the set, to check it and satisfy my own curiosity as to just how well it had stood up over all those years?

So, a week or so later, when making

AND SO I HAD PACKED AS MUCH GEAR AS WAS PRACTICAL

a call in the area, I took a punt and knocked on the door. When the lady answered I explained that I was simply making a courtesy call in case she needed any more advice about a new set and to ask whether I could have a look at the old set out of curiosity.

She greeted me warmly and invited me in to see her new set. It turned out to be a 48cm Samsung and she was very happy with it. Then a tray appeared carrying the inevitable cuppa accoutrements – teapot, cups and saucers, and chocolate biscuits. And so we sat and chatted for a while.

Eventually, I raised the matter of the old set again. Yes, of course, it was in the back room. And I could have it if I wanted it; she was a loss to know what to do with it. I went through the motions of protesting but she was adamant; take it away.

And so, after a pleasant interlude, I came away with the old set. I didn't regard it as valuable in the financial sense but I valued it for what I might learn from it.

Back at the shop, I lost no time in setting it up. In most respects, its performance was first class – a good sharp picture, excellent geometry, normal sound, no tuner problems and no noisy controls. It was quite remarkable for a 16-year old set, with only one service job in that time.

But the colour – yes, that was crook. I fed in a colour bar pattern and, as in the original case, the green was very weak. Also, the red was flaring but the blue was about normal. Just for the heck of it, I went through the motions of grey scaling and this improved things a little. But it was still very poor.

Picture tube rejuvenation

So what now? Did I have any more tricks? Well, there was one other possibility but it was a Sydney-or-the-bush approach. What about a spot of picture tube rejuvenation?

There are various devices for this but the basic principle is pretty much the same. Normally, the heater is run at its rated voltage, although some authorities recommend overrating it somewhat. I prefer not to. After that, a voltage of between 600V and 700V is applied to the grid for about two seconds. This typically creates some brief fireworks around the cathode area and the idea is to keep applying short bursts until this activity ceases.

It's very much a gamble. Sometimes it works and sometimes it doesn't. And even when it does, there is no guarantee as to how long the effect will last. But what did I have to lose?

So I set up the booster and went over each gun in turn. Significantly, I needed to give the green gun about eight bursts before all the fireworks ceased. For the others, one or two bursts were sufficient.

Next, I went through the grey sca ing process again. It was much in proved now; almost good enough, i fact. But there was one limitatio which is common with weak tube whereby the grey scale tends to var with the setting of the brightness cor trol.

In this case, turning the brightnes down would increase the green leve in the lowlights, while turning it u had tended to emphasise the red. Th best that one can do is try to balanc things at what would be regarded as typical brightness viewing level.

So this was what I did. I then let it run in the workshop for a couple o days to see how it would hold, this being the critical aspect of tube boosting. And it did shift, again involving the green.

I gave the green gun a second short boost and grey scaled it again, which again improved things a little. So that's where it stands at the time of writing. I hope it might stabilise a little more with time but I know I'm being optimistic.

So of what use is it now? Well, not much for serious bench work, although it could serve as a loan set in an emergency. But what I am really hoping is that I might score a suitable tube from a set written off for other reasons. If that should happen, I may have a set that's good for a few more years – but not 11!

Serviceman's holiday

And now for a complete change of scene – literally. After several months of planning, I recently set off on a leisurely trip up the New South Wales north coast on what was partly a holiday and partly a business trip.

Among other things, I had been invited to stop over for a few days with a family I have known for many years but had not actually seen for quite some time, although we have kept in touch. And I had little doubt that they would have an array of electrical and electronic jobs lined up for me.

And so I had packed as much gear as was practical – multimeter, soldering equipment, small tools and an assortment of likely minor components. Outside of that, I could only hope.

And so I found myself settled in and we spent some hours mulling over old times and catching up on all that had been happening. But then came

ne practical problems of the present, n the form of a video recorder which ıad begun to play up just a few days ɔefore I arrived.

It was a Sharp model VC-505X, a nodel with which I have had very ittle experience and, without a manıal, I was starting behind scratch. The problem itself was that, at times, the machine would go into the play – or record – mode briefly, then shut itself down. And it was similarly erratic in fast forward or rewind modes.

Anyway, the recorder was taken out of its cabinet and set up on a small table. Since the problem was a mechanical one, there was no need for a TV set connection at that stage. I pulled the cover off, pushed in a tape, and set it running.

It loaded and ran normally the first time and for the next several tries but then suddenly baulked. And the primary reason was immediately obvious; the take-up reel had stopped and the take-up reel sensor had shut the machine down. We then tried the fast forward and rewind functions, with the same results.

Well, there was obviously a fault somewhere in the reel drive mechanism and this was the first hurdle. As I mentioned earlier, I am not very familiar with this machine; all I knew was that it used an unusual reel drive system. Most machines use a rubber-tyred idler wheel and this is supported on the end of a short arm which toggles to one side or the other and engages the wheel with the appropriate reel drive.

Instead of the tyred wheel, this machine has a gear wheel mounted on the end of the arm. This toggles from side to side in a similar manner and engages a matching gear in the reel drive train. But that's not all; as well as moving from side to side, the arm carrying this gear also moves up and down. This movement is probably necessary to ensure smooth engagement of the gears.

That much established, I took a breather. In addition to the main problem, I was also aware of several routine things that needed to be done. One was a general clean-up of the capstan, heads and guides, which were a trifle grotty. Another was to fit new belts.

There are only three belts in this machine; one from the capstan motor to the capstan drum and flywheel and two associated with the loading motor. They weren't in bad nick but since it would probably be long time before I serviced the machine again, it seemed prudent to replace them if possible.

Of course I didn't have any such belts with me, or any cleaning alcohol. So, when the family announced a visit to the nearest large shopping centre, I jumped at the opportunity to try for what I needed.

Medicinal alcohol

Well, I was lucky. I found a TV service centre which had suitable belts and an obliging chemist who dispensed a small bottle of medicinal alcohol. Thus equipped, I completed the various routine tasks without incident but the mechanical problem remained a mystery. The problem was that the mechanism would not function at all unless there was a cassette in it and when there was a cassette in place, it was impossible to see the mechanism.

The solution was crude but effective. My friend had several old tapes on hand which had been put aside due to wear or other faults. So I pulled

SILICON CHIP

SILICON CHIP FLOPPY INDEX

Now available: the complete index to all SILICON CHIP articles since the first issue in November 1987. Now you can search through all the articles ever published for the one you want. Whether it is a feature article, a project, a circuit notebook item, an article by one of our regular contributors or a major product review, it does not matter; they are all there, for you to browse through.

The index comes as an ASCII file on a 3.5-inch or 5.25-inch floppy disc to suit IBM compatible computers and you can use any word processor program to search using a keyword such as "Amplifier".

The Floppy Index is available throughout Australia for $6 plus $3 postage and packing. You nominate 3.5-inch or 5.25-inch format.

Send your order to SILICON CHIP, PO Box 139, Collaroy, NSW 2097; or fax your order to (02) 979 6503; or ring (02) 979 5644 and quote your credit card number. We accept credit card authorisations for Bankcard, Visacard and Mastercard.

CEBus AUSTRALIA KITS

CEBus Australia has opened the Circuit Cellar door to bring you a range of high quality, educational electronics kits. There are three types of kit available: an Experimenter's Kit which includes the PCBs, manuals, any key components that are hard to find and the basic software required by the finished product. Then there is the Complete Kit which includes everything above plus the additional components required to complete the kit. Finally, there is the complete kit with Case & Power Supply.

Regardless of which kit you purchase you get the same high quality solder masked and silk screened PCB and the same prime grade components.

Our range of kits includes:

HAL-4 4 Ch, EEG Monitor, Complete kit only $356.00

Experimenter's Kits:

SmartSpooler, 256K print spooler $214.00
IC Tester, Tests 74xx00 family ICs $233.00
Serial EPROM Programmer, For 27xxx devices $214.00
Ultrasonic Ranger Board with Transducer $194.00

NB: The above prices DO NOT include sales tax.

Don't forget we also have the HCS II, Home Control System, available, Its features include: Expandible Network, Digital & Analog 1/O, X-10 Interface, Trainable IR Interface and Remote Displays.

Call fax or write to us today for more information.

Bankcard, Mastercard & Visa accepted.

CEBus AUSTRALIA.

Ph (03) 467 7194. Fax (03) 467 8422.
PO Box 178, Greensborough, Vic 3087.

one of these apart, removed the tape, and cut a small opening in the bottom. The result was a crude version of the commercial transparent dummy cassette I use in my workshop.

With this in place, it all became clear. The reason the gear was not engaging was simply because the arm holding it was not lifting through the full distance. Well, that took me one step closer but the reason for this failure still had to be determined.

In the event, this was the easy part. Closer examination revealed that the vertical shaft on which the gear arm moved up and down had become gummy due to some kind of lubricant, applied either during production or subsequently.

A good swabbing down with alcohol cleaned this away and that was the answer. I chose not to lubricate it again; it was a plastic bearing moving up and down on a metal shaft and I seriously question the need to lubricate such a simple movement.

Broken tape

So that was that problem solved. But hardly had I heaved a mental sigh of relief than another one landed on my plate. It was a broken tape. More specifically, it was a recorded program which, while of no long-term value, was of considerable immediate interest. But they had seen only the first 15 minutes or so of it when the tape broke.

As nearly as I could work out, the tape had been running for about 15 minutes when it became necessary to stop play for some reason. But then the recorder went cranky and would not start again. In the process, it had formed a small tape loop before the machine shut down. This loop then became tangled and the tape broke when the cassette was ejected from the machine.

While not a common problem, it is not the first time a customer has turned up with a broken tape, begging for help. On my own bench it would be no problem. After the first couple of incidents, I invested in cheap tape splicer. It is a simple jig which holds the tape with the broken ends overlapping. An angled slot then guides a sharp blade to make a clean cut through both layers. The two ends now left butting together are joined with an adhesive patch.

In spite of the jig's low cost, it works quite well and has helped several customers. Prior to that, I had resorted to a more primitive approach. This involved making a simple overlap joint using an acetone-based adhesive, on the understanding that this joint would be used only to play the remainder of the tape and that it would not pass over the heads or capstan.

Crude though it was, this idea worked too and it seemed that I would have to resort to a similar trick in this case. My friend's workshop yielded a tube of clear acetone based adhesive and I went to work on the break, finishing up with reasonably neat joint. But I had no time to test it. It was time for me to leave and I wanted the joint to be left overnight to set properly.

And so I departed, with an invitation to stop over again on my way back in about a week. I had an idea that there might be more jobs waiting for me then but I didn't anticipate anything like what actually happened.

It appeared that the jointing operation had been a complete success and the tape had been played to its conclusion. But when another tape was subsequently played, there was trouble. Although it was a 3-hour tape, at the end of two hours the take-up reel was chock-a-block full, to the point where excessive tape had fouled the bodywork, stopped the reel, and shut the machine down.

Crinkled tape

The basic reason was easy to see – the tape was crinkled, taking up much more space than normal. But why? I could only assume that something in the tape transport path was damaging it. So off came the cover and I went straight to guides, heads and capstan.

And one glance at the capstan was enough. It looked as though it hadn't been cleaned for years, even though I had cleaned it thoroughly only a few days before. More specifically, it displayed the two characteristic dark oxide rings (one tape width apart) that normally occur after prolonged use.

Even more puzzling was the fact that attempts to clean it using alcohol and a tissue proved fruitless; it simply wouldn't budge. Again, this is what one would expect from severe fouling over a long period – often requiring that the capstan be carefully scraped to remove the rubbish. But why after only 3-4 hours of playing?

Anyway, I attacked it with the first thing handy – a fine screwdriver blade. I know that sounds drastic but it isn't really, unless one is woefully heavy handed. And in this case only the lightest touch was necessary; all the fouling moved as one piece and came away as a tubular shell with the oxide rings at each end. The capstan was now as clean as I had left it.

So what was it? The adhesive I had used to join the broken tape. And why? Because the tape had been rewound and, contrary to my advice, the join had passed over the capstan.

How it happened I don't know, and diplomacy dictated that I not stress the point. No real harm had been done apart from the damaged tape and nobody was upset about that. So it all ended happily in the long run.

But I think the lesson is that trying to improvise away from one's own workbench can be fraught with danger. It doesn't always pay to be too clever. **SC**

ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELEC
ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELEC
ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELEC

JAYCAR JANUARY MADNESS SALE

FREE CABINETS WITH VIFA SPEAKER KITS

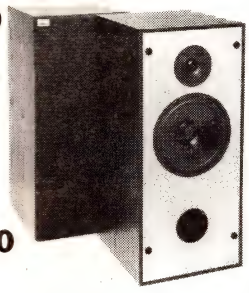
If you purchase a VIFA SA70,100 or 130 speaker kit in January we will give you the cabinets free. There has never been a better time to upgrade your speakers. It is well known that VIFA speakers generally perform as well as built equivalents that cost twice as much. We are overstocked with VIFA cabinets, and need the warehouse space. See catalogue for full details.

Vifa SA70 2 way kit

- Power 70 watts
- 8" woofer
- Dome tweeter

$349 Pair
Cabinets worth $120 FREE

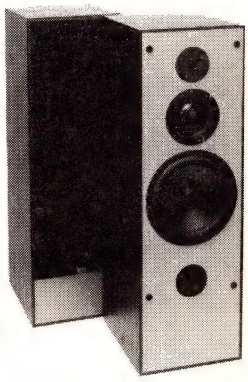
Vifa SA100 2 way kit



- Power 100 watts
- 8"woofer
- Dome tweeter

$549 Pair
Cabinets worth $170 FREE

Vifa SA130 3 way kit

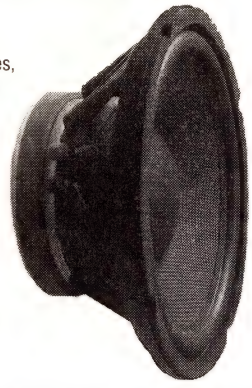


- Power 130 watts
- 10" woofer
- Dome tweeter

$779 Pair
Cabinets worth $250 FREE

QUALITY WOOFERS SLASHED

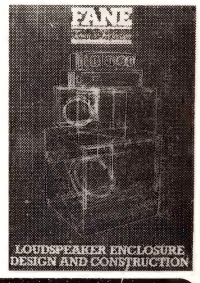
These three speakers are top quality with excellent specifications. Use them as a subwoofer or just a woofer. They have large magnets, pressed polypropylene cones, high power handling and excellent frequency responses. See our catalogue for full specificationss page 36.



	Size: 6"	Size: 10"	Size: 12"
Power handling - RMS	60w	120w	150w
Frequency response	50-3khz	31-2khz	28-2khz
Magnet Weight	20oz(587g)	34oz(988g)	34oz(988g)
Free Air Resonance	50.3hz	31.1hz	28.1hz
Cabinet Size	10 litre	45 litre	48 litre
Cat No	CW-2162	CW-2166	CW-2168
Cat. Price	**$89.50**	**$129.00**	**$159.00**
Sale Price	**$59.50**	**$89.00**	**$119.00**
Save	**$30.00**	**$40.00**	**$40.00**

LOUDSPEAKER PUBLIC ADDRESS BIN ENCLOSURE DESIGNS BOOK

Fane acoustics have produced this excellent book on PA speakers. Learn how to seal, brace, line, wire cabinets Includes 22 detailed designs for reflex, horns, w bins, wedge, folded, cabinets etc Cat. BF-4150



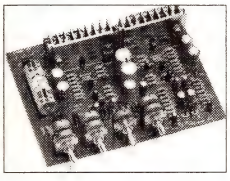
was $19.95
now $14.95
save $5.00

PREBUILT MODULE SPECIALS

See our 1993 Catalogue for full details and specifications.

30 + 30 Watt Stereo Amp

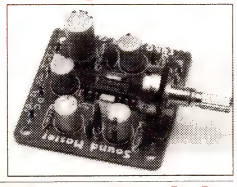
Inputs for MIC, phono + line. Has volume, bass, treble and balance controls. Connect a x'former speakers and a signal
Cat: AA-0300



was $76.95
now $59.95
save $17.00

6 Watt Mono Amplifier

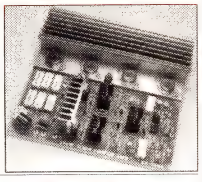
with volume control
Cat: AA-0340



was $19.95
now $16.95
save $3.00

300W Power Amp Module

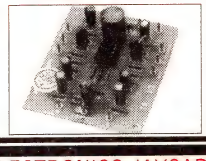
300 watts into 8Ω, 500 into 4Ω
Distortion less than 0.05%
Cat: AA-0330



was $189.50
now $159.50
save $30.00

Stereo Preamp - Mic/Phono

Will bring up a phono input to line level. Cat: AA-0324



was $24.95
now $21.95
save $3.00

SAVE UP TO $50 ON INVERTERS

If you have been considering the purchase of an inverter lately, make it this month and save money. All units have inputs of 12VDC (except MI-5060) and outputs of 240VAC. For full specs and details see our 1993 catalogue.

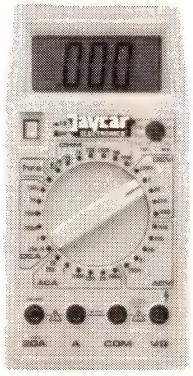
12V / 100 watt
Cat: MI-5035 **Was $134.95**
Jan $114.95, Save $20

12V / 500 watt
Cat: MI-5050 **Was $419.00**
Jan $379.00, Save $40

12V / 300 watt
Cat: MI-5040 **Was $259.00**
Jan $229.00, Save $30

24V / 1000 watt
Cat: MI-5060 **Was $649.00**
Jan $599.00, Save $50

DIGITAL MULTIMETER BREAKTHROUGH!!!



Jaycar Electronics are proud to announce a brand new range of digital multimeters that offer features per dollar that until now was unheard of. Jaycar are sole representatives of this new range, which at the moment has three models, with more due in 1994.

QM-1300

- 30 range
- Large 21mm display
- Transistor test
- Audible continuity test
- 20 amp

Cat: QM-1300
only $49.95

QM-1310

- Frequency
- Capacitance
- Transistor
- 21mm display
- Audible continuity test
- Auto power off
- 20 amp

Cat: QM-1310
only $79.95

KEYTRONIC KEYBOARD

Keytronic keyboards are known throughout the computer industry as top quality! We don't know what this keyboard is compatible with! It has 98 keys and is ideal for the experimenter/computer hobbyist. It is not supplied with a lead.
Size 510(W) x 220(D)mm. Cat. XC-5092

only $10

JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECT
JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECT
JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECT

YCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR

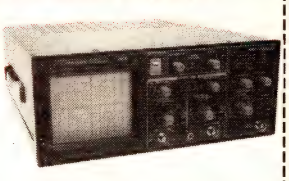
THE LATEST BOOKS

SEE PREVIOUS ADS FOR DETAILS

BT1380	Photocopier Maintenance and Repairs Made Easy	$32.95
BT1378	Basic Electronics Theory	$49.95
BM2484	Batteries, Chargers and Emergency Lights	$19.95
BT1374	Best Mac Tips Ever	$39.95
BT1376	Making Printed Circuit Boards	$39.95
BW3508	Ray Tracing Creations	$79.95
BW3512	Making Movies On Your PC	$69.95
BW3510	Virtual Reality Creations	$69.95
BW3504	Virtual reality Playhouse	$47.95
BX3900	Electronic Devices and Circuits	$56.95
BX3902	OP Amps with Linear IC's	$46.95
BX3904	Intro Circuit Analysis	$57.95
BM2144	Supercharging MS-DOS	$12.95
BM2128	The Norton Utilities	$7.95
BM2142	Learn Microsoft Word Now	$19.95

CRO BARGAINS FROM JAYCAR

20Mhz Dual Trace CRO



TWO FREE CRO PROBES SUPPLIED WITH EVERY PURCHASE - VALUE $79.00

Cat: QC-1900 **Only $699**

6.4Mhz CRO was $379 now $349 save $30

Cat: QC-1908

AA NICAD BATTERIES

700mAh with solder tags - Cat. #: SB2451 $3.75 each

500mAh rechargable - Cat. #: SB-2452 **4 for $10.00**

500mAh with solder tags - Cat. #: SB2453 **$2.95 each**

700mAh rechargable - Cat. #: SB2450 **$3.50 ea or 4 for $12.50**

UPGRADE YOUR MIDRANGE

Quality white cone. see catalogue. Power handling 80WRMS system. Frequency response: 350Hz to 5.5kHz.

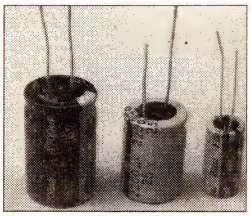
Cat: CM-2080

Was $28.50, Jan $20

NEW RB ELECTROLYTICS

We have increased our range of large capacitance RB electrolytic capacitors. New values are:-

Cat	Capacitance	Voltage	Price
RE6241	2200uf	50v	$3.50
RE6244	4700uf	25v	$3.25
RE6242	3300uf	50v	$4.95
RE6245	4700uf	50v	$5.95
RE6247	10,000uf	25v	$6.95



TELEPHONE TONE DIALLER BARGAIN

GENERATES DTMF SIGNALS

For use in conjunction with telephone answering machines, remote banking, computers, electronic voice mail and call diverters. Was selling for $19.95. Now an amazing half price. This product is not Austel approved.

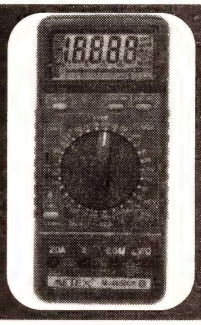
Cat: YT-6155 **Was $9.95 January $5.00**

METEX 4.5 DIGIT RS232 DIGITAL MULTIMETER SALE

Features:
•Bargraph •Frequency •Transistor •Logic •Relative Offset •20 Amp Current •Carry Case •Overload Protection •Data Hold •Min/Max Hold •Diode and Continuity •Range Selector Beeper. - See catalogue for full details.

Cat. QM-1460

Was $269.50 January Special $239.50 Save $30



LOW COST DMM REDUCED EVEN FURTHER

Features: •3.5 digit 12.5mm LCD display •Transistor test •Diode test •10 amp current •Plug in leads. Full feature meter with plug in 4mm probes and transistor tester for under $30!!! This is the ideal first multimeter, and will give years of faithful service.

Cat. #: QM-1500

Was $34.95 Only $29.95

SAVE ON HOTSOL GAS SOLDERING IRONS

Hot-Sol Iron

See catalogue for details. Standard HOTSOL with 2.4mm soldering tip.

Cat. TS-1700

was $38.95 now $32.95 save $6

Hot-Sol Service Kit

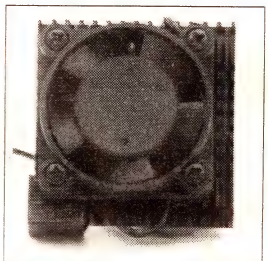
This kit includes the same soldering iron as above, but comes with a range of accessories and it's all housed in its own case. Includes:
•Hot-Sol Butane Gas Tool •Protective Cap •Non-slip stand with sponge •Torch Tip which gives a flame •2.4mm Soldering Tip •Hot Blow Tip for shrinking heatshrink •Scoop for feeding tubing to hot blow tip • Hot Knife Tip •Roll Solder •Case which holds everything

Cat. TS-1702 **was $64.95 now $49.95 save $15**

CPU COOLER REDUCED

REVIEWED IN ELEC AUST - 9/93

Is your 486 running too hot? Do you live in the hotter areas of Australia? Many CPU's run too hot. With our new CPU cooler you can forget all that. The CPU cooler is easy to mount, you don't need to remove the CPU. It incorporates a heatsink which clips over the CPU and is held there by a special clip. It's supplied with a piggyback plug arrangement for power. Simply unplug the power connector inside and plug the CPU cooler in-line. Installation should take all of about 3 minutes.



Cat: XC-5040 **Was $39.95 Now $29.95 Save $10**

9 V RECHARGEABLE BATTERY BARGAIN

Normally $19.95

January $15.00

Save $4.95

Cat: SB-2458

JAYCAR RESELLER WANTED IN PERTH
Please call our Wholesale Department on (02) 743-5222

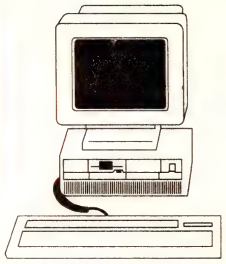
YCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR

ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR

JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS

COMPUTER BITS

BY DARREN YATES



Even more experiments for your games card

In the November 1993 issue, we used some simple programming so that the games card could function as an analog interface. Now we take a look at how to obtain higher speed interfacing using some simple assembly language routines.

If you read the last instalment of this series, you'll probably think that using straight MS-DOS QBasic is just too slow and, in most cases, you're right. Any language which is designated as an "interpreter" can usually be regarded as "slow".

However, one of the forgotten programming languages is Assembly Language which is faster than any compiler you could lay your hands on. What's more, you have access to it through QBasic!

Now most people, even competent programmers, seem to baulk at the idea of using assembler code as either being "old-fashioned" or "too hard to use". But if you can program in BASIC, there's no reason why, with a little care, you can't do likewise with Assembler.

Those of you who go back far enough will remember the DREAM 6800 and ETI-660 microcomputers which came onto the scene before the days of the TRS80s and Commodore 64s. Programming on the former was done by a form of machine code and by just following simple steps, even yours truly, as a 9-year old, could write simple software on them.

By the way, if you still use a TRS80 or Commodore 64, then there's no reason why you can't keep using them for years to come. OK, so they may be pushing 20 years old, but if you're a hobbyist who wants to interface your own projects with them, then they're ideal.

The main benefit the IBM PC compatible has in this area is just the sheer volume of information that is available on the internals - information which is hard to get on other machines.

BIOS & DOS interrupts

Getting back to machine code, Microsoft have taken most of the hard work out of writing assembler or "machine code" routines by supplying many routines as part of your machine's disc operating system (DOS). Other routines are supplied as part of the built-in operating system (BIOS) which comes in one or two ROMs on the motherboard.

These two sets of routines allow you to get at the hardware of your machine without having to worry about the bulk of the programming. For example, you can set the time and date directly, check to see if your motherboard has a co-processor, check the number of printer ports or what's on the printer ports, and so on. You can even display a message about the motherboard from its manufacturer. The list goes on and on. However, at this point, we'll just look at those routines that pertain to the games card.

Clock speed

Back in the first article on using the games card (SILICON CHIP, January 1992), we looked at the circuitry of the games card to see how it was able to translate the joystick position into an 8-bit count. Recounting briefly, the games card contains a 558 quad timer IC which is wired as four monostables. Each x- and y-section of the joystick is a separate variable resistor which is connected up with one section of the 558 to form a monostable.

To read back the digital count, the computer triggers the monostable and at the same time starts an 8-bit count. When the monostable falls low again, the count is stopped. Now this method is obviously going to be slow, particularly if it has to count to 256 on each scan and, as a result, the frequency of scanning is around 800Hz.

When you couple this with QBasic's relatively low speed, you can now see why the simple analog interface we built last time could only handle 40 samples per second. However, by using a small amount of machine code, we can increase this by about 10-fold.

QBASIC & machine code

Those of you who aren't familiar with QBASIC will be surprised at its easy-to-use interface compared with GWBASIC. There have been a couple of small changes in the language, particularly with respect to using machine code.

QBASIC gives the user direct control of the PC via a command called

Fig.1: Games Card Finder Program

```
' Games card finder program
' Copyright 1993 Silicon Chip Publications
' Written by Darren Yates B.Sc.
' This program prints a message indicating whether or not
' a games card is installed.
' It uses a machine-language program stored in an array
' to get the information from the operating system.
DEFINT A-Z
DIM Asmprog(1 TO 7)

' The machine-language program stored as data to read into
' the array.
AsmBytes:
DATA &H55                 : 'PUSH BP          Save base pointer.
DATA &H8B, &HEC           : 'MOV  BP,SP       Get our own.
DATA &HCD, &H11           : 'INT  11H         Make the ROM-BIOS call.
DATA &H8B, &H5E, &H06     : 'MOV  BX,[BP+6]   Get argument address.
DATA &H89, &H07           : 'MOV  [BX],AX     Save list in argument.
DATA &H5D                 : 'POP  BP          Restore base pointer.
DATA &HCA, &H02, &H00     : 'RET  2           Pop argument off stack
                                              and make far return.
' Get the starting offset of the array.
start = VARPTR(Asmprog(1))
' Poke the machine-language program into the array.
DEF SEG = VARSEG(Asmprog(1))' Change the segment.
RESTORE AsmBytes
FOR index = 0 TO 13
    READ byte
    POKE (start + index), byte
NEXT index

' Execute the program. The program expects a single integer argument.
start = VARPTR(Asmprog(1))
CALL ABSOLUTE(status%, start)
DEF SEG   ' Restore the segment.
' status% now contains bit-encoded equipment list returned by DOS.
' Mask off all but the games card bit (bit 12).
game = status% AND &HC000
' Print the appropriate message.
IF game = 16384 THEN
  PRINT "Games Card present."
ELSE
  PRINT "No Games Card."
END IF
END
```

CALL ABSOLUTE() which transfers control to machine code elsewhere in the program. A simple example of this is found in GAMECARD.BAS in Fig.1. This program checks the hardware of your computer to see whether it has a games card connected.

If you're writing your own programs to use a games card, you can use this routine to check if one exists in the computer before going further. This is a good idea because it saves the user the frustration of not knowing why the program won't work.

Looking at the program, the machine code is stored away in an integer array called ASMPROG. If you count through the data statements, there are 14 bytes of instructions but since an integer variable consists of two bytes, we only need seven to store away the program.

Looking at the machine code bytes, each line contains the bytes required to execute that function – some require only one byte while others need three. The first line saves the current base pointer and puts it on the stack. The base pointer is a pointer to the current address of the last instruction and the reason we need to save this is that when we run or "call" this routine, we are effectively transferring control from one language to another. The base pointer performs the task of a "bookmark" – showing us where to go back to after we've finished.

Next, we have to transfer our current base pointer of this program area, which is the array ASMPROG, into the BP register. This is to make sure that we use the correct area of memory.

The next line performs an interrupt, which tells the computer to stop everything and run the routine which is designated 11 in the BIOS ROM. This returns a value to the AX register which contains the information shown in Table 1.

The AX register is 16-bits wide and each bit is used to indicate which parts of the hardware are present or absent. Bit 0 shows whether or not there is a floppy drive. Few computers don't have a floppy drive of some kind so this will invariably be '1'. Bit 1 shows if a co-processor is installed; bit 2 shows if you have a mouse installed; bits 4 and 5 show which video mode you're in; bits 6 and 7 how many floppy drives you have minus one; bits 9-B how many RS-232 cards you have; bit C if you have a games card; and bits E and F how many printer ports you have.

Now we want the machine code program to return this value of AX back to the variable STATUS%. To do this, we need to know the address of this variable and this is what the 4th line does.

It uses "indirect addressing" to load into register BX not the value of BP+6 but the address of this position. The next line loads the contents of AX, not into BX but the address of the contents of BX, which in our case is the address of variable STATUS%.

This sounds pretty long winded but it is a powerful way of using only a small number of registers to access a wide area of memory.

Now that we've completed what we set out to do, we must restore everything and leave the stack the way we found it and that requires us to 'pop' the contents of the original

Table 1: Bit Meanings

E	D	C	B	A	9	8	7	6	5	4	3	2	1	0	Meaning of bits
x															Number of printers attached
	x														Not used
		0													Game adapter not installed
		1													Game adapter installed
			x	x	x										Number of serial cards attached
						x									Not used
							0	0							1 disc drive attached (if bit 0 = 1)
							0	1							2 disc drives attached (if bit 0 = 1)
							1	0							3 disc drives attached (if bit 0 = 1)
							1	1							4 disc drives attached (if bit 0 = 1)
									0	1					Initial video mode - 40 x 25 BW/colour card
									1	0					Initial video mode - 80 x 25 BW/colour card
									1	1					Initial video mode - 80 x 25 BW/mono card
											0	0			16K system board RAM
											0	1			48K system board RAM
											1	0			32K system board RAM
											1	1			64K system board RAM
													1		Math coprocessor installed
														0	No disc drives installed (bits 6-7 insignificant)
														1	Disc drives installed (bits 6-7 significant)

base pointer from the stack and put it back into register BP. The last line does what's called a 'far return' which means that it returns control from the machine code program back to the next instruction of the QBASIC program, wherever in the memory that may be.

This machine code is loaded in via a FOR..NEXT loop using the POKE command. Before this happens, there are two commands carried out to make sure that these bytes go in exactly the right spot and these involve the commands VARPTR and VARSEG.

Since the PC memory is divided into 64Kb segments, we have to know which of these segments the array ASMPROG is sitting in. This is carried out by the VARSEG command which sets the current segment pointer to this segment.

Next, we have to know where in that segment this array is and this is done by the VARPTR command which puts the location of the first array element of ASMPROG into the variable START.

The command which calls the machine code is CALL ABSOLUTE(STATUS%, START) with STATUS% the variable we want the information returned in, while START tells the computer which memory address to begin the machine code program. Once it's carried out, control is return to the next line of the program, which restores the segment back to the QBASIC program.

Next up, variable GAME is used to store the single bit of information we need and we get this by ANDing the STATUS value with the hexadecimal number 8000. The end result of this is that if the computer has a games card, then GAME will equal '16384' and '0' otherwise. We simply use it in this case to print the appropriate message on screen.

This program will run under QBASIC in either DOS 5 or DOS 6, as well as QuickBASIC 4.5. All of the programs mentioned so far in this games card series, including GAMECARD.BAS and .EXE versions, are available from SILICON CHIP for $10 including postage and packaging. Please specify either a 5.25-inch 3.5-inch disc as required. You can call (02) 979 5644 with your credit card details or send them via fax to (02) 979 6503.

Next time, we'll continue by looking at the games port address and how it can be used.

References

(1) Using Assembly Language; 2nd edition, Allen L. Wyatt, Que Corporation 1990.

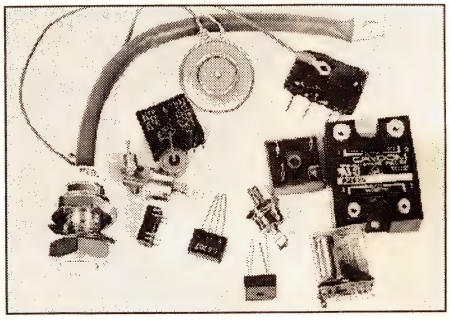
(2) The Programmer's PC Sourcebook; 2nd edition, Thom Hogan, Microsoft Press 1991. **SC**

POWER PRODUCTS!

We offer CONVENIENCE — let us source and quote your POWER ELECTRONICS. Saves you TIME and MONEY. Delivery is from stock, or on short lead time. Here's a sample of the products we support:

RELAYS

- PCB MOUNT
- SOLDER TAB
- SOCKET MOUNT
- POWER RELAYS
- CONTACTORS
- LATCHING
- IMPULSE
- ROTARY
- REED
- AUTOMOTIVE
- SOLID STATE
- TIME DELAY
- CIRCUIT BREAKERS
- I/O MODULES



POWER SEMICONDUCTORS

- PHASE CONTROL THYRISTORS (to 1900A)
- FAST THYRISTORS (to 1000 Amps)
- ASYMMETRIC THYRISTORS
- TRIACS (to 50 Amps)
- POWER DIODES (to 350 Amps)
- HOCKEY PUK DIODES (to 5800 Amps)
- HIGH VOLTAGE DIODES & STICKS (to 200 Kv)
- DIODE & THYRISTOR MODULES (to 285A)
- SINGLE PHASE BRIDGE RECT. (to 55A)
- THREE PHASE BRIDGE RECT. (to 160A)
- TRANSISTOR MODULES (to 400 Amps)

ALSO — POWER RESISTORS to 750 Watts, ELECTRON TUBES — magnetrons, thyratrons, ignatrons, klystrons...MICROWAVE PRODUCTS — hexalators, circulators, gunn diodes, mixers, detectors...WORLD-WIDE INDUSTRIAL VALVE/TUBE SOURCING.

EL ALL ELECTRONIC COMPONENTS
118 LONSDALE ST, MELBOURNE VIC 3000.
PH: (03) 662 3506 FAX: (03) 663 3822

FOR MORE INFORMATION
PLEASE CONTACT
(03) 662 3506

Silicon Chip BACK ISSUES

September 1988: Hands-Free Speakerphone; Electronic Fish Bite Detector; High Performance AC Millivoltmeter, Pt.2; Build The Vader Voice; Motorola MC34018 Speakerphone IC Data; What Is Negative Feedback, Pt.4.

November 1988: 120W PA Amplifier Module (Uses Mosfets); Poor Man's Plasma Display; Automotive Night Safety Light; Adding A Headset To The Speakerphone; How To Quieten The Fan In Your Computer; A Look At Diesel Electric Locomotives.

December 1988: 120W PA Amplifier (With Balanced Inputs), Pt.1; Diesel Sound Generator; Car Antenna/Demister Adaptor; SSB Adaptor For Shortwave Receivers; Why Diesel Electrics Killed Off Steam; Index to Volume 1.

March 1989: LED Message Board, Pt.1; 32-Band Graphic Equaliser, Pt.1; Stereo Compressor For CD Players; Amateur VHF FM Monitor, Pt.2; Signetics NE572 Compandor IC Data; Map reader For Trip Calculations; Electronics For Everyone – Resistors.

April 1989: Auxiliary Brake Light Flasher; Electronics For Everyone: What You Need to Know About Capacitors; Telephone Bell Monitor/ Transmitter; 32-Band Graphic Equaliser, Pt.2; LED Message Board, Pt.2.

May 1989: Electronic Pools/Lotto Selector; Build A Synthesised Tom-Tom; Biofeedback Monitor For Your PC; Simple Stub Filter For Suppressing TV Interference; LED Message Board, Pt.3; All About Electrolytic Capacitors.

June 1989: Touch-Lamp Dimmer (uses Siemens SLB0586); Passive Loop Antenna For AM Radios; Universal Temperature Controller; Understanding CRO Probes; LED Message Board, Pt.4.

July 1989: Exhaust Gas Monitor (Uses TGS812 Gas Sensor); Extension For The Touch-Lamp Dimmer; Experimental Mains Hum Sniffers; Compact Ultrasonic Car Alarm; NSW 86 Class Electric Locomotives.

September 1989: 2-Chip Portable AM Stereo Radio (Uses MC13024 and TX7376P) Pt.1; Alarm-Triggered Telephone Dialler; High Or Low Fluid Level Detector; Simple DTMF Encoder; Studio Series 20-Band Stereo Equaliser, Pt.2; Auto-Zero Module for Audio Amplifiers (Uses LMC669).

October 1989: Introducing Remote Control; FM Radio Intercom For Motorbikes Pt.1; GaAsFet Preamplifier For Amateur TV; 1Mb Printer Buffer; 2-Chip Portable AM Stereo Radio, Pt.2; Installing A Hard Disc In The PC.

November 1989: Radfax Decoder For Your PC (Displays Fax, RTTY & Morse); FM Radio Intercom For Motorbikes, Pt.2; 2-Chip Portable AM Stereo Radio, Pt.3; Floppy Disc Drive Formats & Options; The Pilbara Iron Ore Railways.

December 1989: Digital Voice Board (Records Up To Four Separate Messages); UHF Remote Switch; Balanced Input & Output Stages; Da For The LM831 Low Voltage Amplifier IC; Insta ing A Clock Card In Your Computer; Index Volume 2.

January 1990: High Quality Sine/Square Oscill tor; Service Tips For Your VCR; Speeding U Your PC; Phone Patch For Radio Amateurs; A tive Antenna Kit; Speed Controller For Ceilir Fans; Designing UHF Transmitter Stages.

February 1990: 16-Channel Mixing Desk; Hig Quality Audio Oscillator, Pt.2; The Incredible H Canaries; Random Wire Antenna Tuner For Metres; Phone Patch For Radio Amateurs, Pt.2 PC Program Calculates Great Circle Bearings.

March 1990: 6/12V Charger For Sealed Leac Acid Batteries; Delay Unit For Automatic Anter nas; Workout Timer For Aerobics Classes; 16 Channel Mixing Desk, Pt.2; Using The UC390(SLA Battery Charger IC.

April 1990: Dual Tracking ±50V Power Supply VOX With Delayed Audio; Relative Field Strength Meter; 16-Channel Mixing Desk, Pt.3; Active CW Filter For Weak Signal Reception; How To Finc Vintage Radio Receivers From The 1920s.

June 1990: Multi-Sector Home Burglar Alarm; Low-Noise Universal Stereo Preamplifier; Load Protection Switch For Power Supplies; A Speed Alarm For Your Car; Design Factors For Model Aircraft; Fitting A Fax Card To A Computer.

July 1990: Digital Sine/Square Generator, Pt.1 (Covers 0-500kHz); Burglar Alarm Keypad & Combination Lock; Simple Electronic Die; Low-Cost Dual Power Supply; Inside A Coal Burning Power Station; Weather Fax Frequencies.

August 1990: High Stability UHF Remote Transmitter; Universal Safety Timer For Mains Appliances (9 Minutes); Horace The Electronic Cricket; Digital Sine/Square Wave Generator, Pt.2.

September 1990: Music On Hold For Your Telephone; Remote Control Extender For VCRs; Power Supply For Burglar Alarms; Low-Cost 3-

Use this handy form to order your back issues

Please send me a back issue for:

- ❑ March 1989
- ❑ September 1989
- ❑ February 1990
- ❑ August 1990
- ❑ January 1991
- ❑ June 1991
- ❑ November 1991
- ❑ April 1992
- ❑ September 1992
- ❑ February 1993
- ❑ July 1993
- ❑ December 1993
- ❑ April 1989
- ❑ October 1989
- ❑ March 1990
- ❑ September 1990
- ❑ February 1991
- ❑ July 1991
- ❑ December 1991
- ❑ May 1992
- ❑ October 1992
- ❑ March 1993
- ❑ August 1993
- ❑ September 1988
- ❑ May 1989
- ❑ November 1989
- ❑ April 1990
- ❑ October 1990
- ❑ March 1991
- ❑ August 1991
- ❑ January 1992
- ❑ June 1992
- ❑ November 1992
- ❑ April 1993
- ❑ September 1993
- ❑ November 1988
- ❑ June 1989
- ❑ December 1989
- ❑ June 1990
- ❑ November 1990
- ❑ April 1991
- ❑ September 1991
- ❑ February 1992
- ❑ July 1992
- ❑ December 1992
- ❑ May 1993
- ❑ October 1993
- ❑ December 1988
- ❑ July 1989
- ❑ January 1990
- ❑ July 1990
- ❑ December 1990
- ❑ May 1991
- ❑ October 1991
- ❑ March 1992
- ❑ August 1992
- ❑ January 1993
- ❑ June 1993
- ❑ November 1993

Enclosed is my cheque/money order for $_____or please debit my: ❑ Bankcard ❑ Visa Card ❑ Master Card

Card No. | | | | | | | | | | | | | | | | |

Signature _____ Card expiry date_____ /_____

Name _____

Street _____

Suburb/town _____ Postcode _____

Note: all prices include post & packing

Australia (by return mail) $A7
NZ & PNG (airmail) $A7
Overseas (airmail) $A10

Detach and mail to:
Silicon Chip Publications, PO Box 139, Collaroy, NSW, Australia 2097.

Or call (02) 979 5644 & quote your credit card details. Fax (02) 979 6503.

igit Counter Module; Simple Shortwave Converter For The 2-Metre Band.

October 1990: Low-Cost Siren For Burglar Alarms; Dimming Controls For The Discolight; Surfsound Simulator; DC Offset For DMMs; The Dangers of Polychlorinated Biphenyls; Using The IE602 In Home-Brew Converter Circuits.

November 1990: How To Connect Two TV Sets To One VCR; A Really Snazzy Egg Timer; Low-Cost Model Train Controller; Battery Powered Laser Pointer; 1.5V To 9V DC Converter; Introduction To Digital Electronics; Simple 6-Metre Amateur Transmitter.

December 1990: DC-DC Converter For Car Amplifiers; The Big Escape – A Game Of Skill; Wiper Pulser For Rear Windows; Versatile 4-Digit Combination Lock; 5W Power Amplifier For The 6-Metre Amateur Transmitter; Index To Volume 3.

January 1991: Fast Charger For Nicad Batteries, Pt.1; Have Fun With The Fruit Machine; Two-Tone Alarm Module; Laser Power Supply; LCD Readout For The Capacitance Meter; How Quartz Crystals Work; The Dangers When Servicing Microwave Ovens.

February 1991: Synthesised Stereo AM Tuner, Pt.1; Three Inverters For Fluorescent Lights; Low-Cost Sinewave Oscillator; Fast Charger For Nicad Batteries, Pt.2; How To Design Amplifier Output Stages; Tasmania's Hydroelectric Power System.

March 1991: Remote Controller For Garage Doors, Pt.1; Transistor Beta Tester Mk.2; Synthesised AM Stereo Tuner, Pt.2; Multi-Purpose I/O Board For PC-Compatibles; Universal Wideband RF Preamplifier For Amateurs & TV.

April 1991: Steam Sound Simulator For Model Railroads; Remote Controller For Garage Doors, Pt.2; Simple 12/24V Light Chaser; Synthesised AM Stereo Tuner, Pt.3; A Practical Approach To Amplifier Design, Pt.2; Playing With The Ansi.Sys File; FSK Indicator For HF Transmissions.

May 1991: 13.5V 25A Power Supply For Transceivers; Stereo Audio Expander; Fluorescent Light Simulator For Model Railways; How To Install Multiple TV Outlets, Pt.1; Setting Screen Colours On Your PC.

June 1991: A Corner Reflector Antenna For UHF TV; 4-Channel Lighting Desk, Pt.1; 13.5V 25A Power Supply For Transceivers; Active Filter For CW Reception; Electric Vehicle Transmission Options; Tuning In To Satellite TV, Pt.1.

July 1991: Battery Discharge Pacer For Electric Vehicles; Loudspeaker Protector For Stereo Amplifiers; 4-Channel Lighting Desk, Pt.2; How To Install Multiple TV Outlets, Pt.2; Tuning In To Satellite TV, Pt.2; PEP Monitor For Transceivers.

August 1991: Build A Digital Tachometer; Masthead Amplifier For TV & FM; PC Voice Recorder; Tuning In To Satellite TV, Pt.3; Installing Windows On Your PC; Step-By-Step Vintage Radio Repairs.

September 1991: Studio 3-55L 3-Way Loudspeaker System; Digital Altimeter For Gliders & Ultralights, Pt.1; Build A Fax/Modem For Your Computer; The Basics Of A/D & D/A Conversion; Windows 3 Swapfiles, Program Groups & Icons.

October 1991: Build A Talking Voltmeter For Your PC, Pt.1; SteamSound Simulator Mk.II; Magnetic Field Strength Meter; Digital Altimeter For Gliders & Ultralights, Pt.2; Getting To Know The Windows PIF Editor.

November 1991: Colour TV Pattern Generator, Pt.1; Battery Charger For Solar Panels; Flashing Alarm Light For Cars; Digital Altimeter For Gliders & Ultralights, Pt.3; Build A Talking Voltmeter For Your PC, Pt.2; Modifying The Windows INI Files.

December 1991: TV Transmitter For VCRs With UHF Modulators; Infrared Light Beam Relay; Solid-State Laser Pointer; Colour TV Pattern Generator, Pt.2; Windows 3 & The Dreaded Unrecoverable Application Error; Index To Volume 4.

January 1992: 4-Channel Guitar Mixer; Adjustable 0-45V 8A Power Supply, Pt.1; Baby Room Monitor/FM Transmitter; Automatic Controller For Car Headlights; Experiments For Your Games Card; Restoring An AWA Radiolette Receiver.

February 1992: Compact Digital Voice Recorder; 50-Watt/Channel Stereo Power Amplifier; 12VDC/240VAC 40-Watt Inverter; Adjustable 0-45V 8A Power Supply, Pt.2; Designing A Speed Controller For Electric Models.

March 1992: TV Transmitter For VHF VCRs; Studio Twin Fifty Stereo Amplifier, Pt.1; Thermostatic Switch For Car Radiator Fans; Telephone Call Timer; Coping With Damaged Computer Directories; Valve Substitution In Vintage Radios.

April 1992: Infrared Remote Control For Model Railroads; Differential Input Buffer For CROs; Studio Twin Fifty Stereo Amplifier, Pt.2; Understanding Computer Memory; Aligning Vintage Radio Receivers, Pt.1.

May 1992: Build A Telephone Intercom; Low-Cost Electronic Doorbell; Battery Eliminator For Personal Players; Infrared Remote Control For Model Railroads, Pt.2; A Look At Large Screen High Resolution Monitors; OS2 Is Really Here; Aligning Vintage Radio Receivers, Pt.2.

June 1992: Multi-Station Headset Intercom, Pt.1; Video Switcher For Camcorders & VCRs; Infrared Remote Control For Model Railroads, Pt.3; 15-Watt 12-240V Inverter; What's New In Oscilloscopes?; A Look At Hard Disc Drives.

July 1992: Build A Nicad Battery Discharger; 8-Station Automatic Sprinkler Timer; Portable 12V SLA Battery Charger; Off-Hook Timer For Telephones; Multi-Station Headset Intercom, Pt.2.

August 1992: Build An Automatic SLA Battery Charger; Miniature 1.5V To 9V DC Converter; Dummy Load Box For Large Audio Amplifiers; Internal Combustion Engines For Model Aircraft; Troubleshooting Vintage Radio Receivers.

September 1992: Multi-Sector Home Burglar Alarm; The Interphone Digital Telephone Exchange, Pt.2; General-Purpose 3½-Digit LCD Panel Meter; Track Tester For Model Railroads; Build A Relative Field Strength Meter.

October 1992: 2kW 24VDC To 240VAC Sinewave Inverter; Multi-Sector Home Burglar Alarm, Pt.2; Mini Amplifier For Personal Stereos; Electronically Regulated Battery Charger (Charges 6V, 12V & 24V Lead-Acid Batteries).

November 1992: MAL-4 Microcontroller Board, Pt.1; Simple FM Radio Receiver; Infrared Night Viewer; Speed Controller For Electric Models, Pt.1; 2kW 24VDC To 240VAC Sinewave Inverter, Pt.2; Automatic Nicad Battery Discharger.

December 1992: Diesel Sound Simulator For Model Railroads; Easy-To-Build UHF Remote Switch; MAL-4 Microcontroller Board, Pt.2; Speed Controller For Electric Models, Pt.2; 2kW 24VDC To 240VAC Sinewave Inverter, Pt.3; Index To Volume 5.

January 1993: Peerless PSK60/2 2-Way Hifi Loudspeakers; Flea-Power AM Radio Transmitter; High Intensity LED Flasher For Bicycles; 2kW 24VDC To 240VAC Sinewave Inverter, Pt.4; Speed Controller For Electric Models, Pt.3.

February 1993: Three Simple Projects For Model Railroads; A Low Fuel Indicator For Cars; Audio Level/VU Meter With LED Readout; Build An Electronic Cockroach; MAL-4 Microcontroller Board, Pt.3; 2kW 24VDC To 240VAC Sinewave Inverter, Pt.5; Making File Backups With LHA & PKZIP.

March 1993: Build A Solar Charger For 12V Batteries; An Alarm-Triggered Security Camera; Low-Cost Audio Mixer for Camcorders; Test Yourself On The Reaction Trainer; A 24-Hour Sidereal Clock For Astronomers.

April 1993: Solar-Powered Electric Fence; Build An Audio Power Meter; Three-Function Home Weather Station; 12VDC To 70VDC Step-Up Voltage Converter; Digital Clock With Battery Back-Up; A Look At The Digital Compact Cassette.

May 1993: Nicad Cell Discharger; Build The Woofer Stopper; Remote Volume Control For Hifi Systems, Pt.1; Alphanumeric LCD Demonstration Board; Low-Cost Mini Gas Laser; The Microsoft Windows Sound System.

June 1993: Windows-Based Digital Logic Analyser, Pt.1; Build An AM Radio Trainer, Pt.1; Remote Control For The Woofer Stopper; A Digital Voltmeter For Your Car; Remote Volume Control For Hifi Systems, Pt.2; Double Your Disc Space With DOS 6.

July 1993: Build a Single Chip Message Recorder; Light Beam Relay Extender; Build An AM Radio Trainer, Pt.2; Windows Based Digital Logic Analyser; Pt.2; Low-Cost Quiz Game Adjudicator; Programming The Motorola 68HC705C8 Microcontroller – Lesson 1; Antenna Tuners – Why They Are Useful.

August 1993: Low-Cost Colour Video Fader; 60-LED Brake Light Array; A Microprocessor-Based Sidereal Clock; The Southern Cross Z80-based Computer; A Look At Satellites & Their Orbits; Unmanned Aircraft – Israel Leads The Way; Ghost Busting For TV Sets.

September 1993: Automatic Nicad Battery Charger/Discharger; Stereo Preamplifier With IR Remote Control, Pt.1; In-Circuit Transistor Tester; A +5V to ±15V DC Converter; Remote-Controlled Electronic Cockroach; Restoring An Old Valve Tester; Servicing An R/C Transmitter, Pt.1.

October 1993: Courtesy Light Switch-Off Timer For Cars; FM Wireless Microphone For Musicians; Stereo Preamplifier With IR Remote Control, Pt.2; Electronic Engine Management, Pt.1; Mini Disc Is Here; Programming The Motorola 68HC705C8 Microcontroller – Lesson 2; Servicing An R/C Transmitter, Pt.2.

November 1993: Jumbo Digital Clock; High Efficiency Inverter For Fluorescent Tubes; Stereo Preamplifier, Pt.3; Build A Siren Sound Generator; Electronic Engine Management, Pt.2; More Experiments For Your Games Card; Preventing Damage To R/C Transmitters & Receivers.

December 1993: Remote Controller For Garage Doors; Low-Voltage LED Stroboscope; Low-Cost 25W Amplifier Module; Peripherals For The Southern Cross Computer; Build A 1-Chip Melody Generator; Electronic Engine Management, Pt.3; Index To Volume 6.

PLEASE NOTE: all issues from November 1987 to August 1988, plus October 1988, January, February & August 1989, and May 1990 are now sold out. All other issues are presently in stock, although stocks are low for some older issues. For readers wanting articles from sold-out issues, we can supply photostat copies (or tearsheets) at $7.00 per article (incl. p&p). When supplying photostat articles or back copies, we automatically supply any relevant notes & errata at no extra charge.

REMOTE CONTROL

BY BOB YOUNG

More on servicing your R/C receiver

Last month, we looked at the mechanical aspects of receiver servicing. This month, we will be looking at the electronic aspects, with an emphasis on AM & FM sets.

To begin, a circuit diagram of the receiver under discussion is a great help (as if you need to be told) and a component overlay is almost as important. There was a time not so long ago (before the popularity of FM) when a good knowledge of one receiver was all you needed to service almost any receiver on the market.

Technology has changed all that. FM brought into vogue the single IC receiver and PCM the in-house microprocessor.

Surface mount technology has added a new complication in that most surface mount components are not marked with values (except resistors) and most components are hardly recognisable. The new through-hole components will be even more horrendous in that they go into vias (ie, plated through holes in the board) and will be invisible. To cap this, knowing designers as I do, they will probably put them in vias which are located under ICs, so we are about to enter the true throwaway era.

All receivers from PCM onwards are outside the scope of this article and must be left to the factory-trained and supported technician. I will be confining this discussion to AM and FM receivers using conventional components and some surface mount.

Check the transmitter

Servicing an AM receiver is a fairly straightforward business and, as usual, involves a strict discipline for the most efficient results. Adequate test equipment is a must and the home serviceman is at a disadvantage if his kit does not include an oscilloscope. I will attempt to include some tips for those with little equipment but you really are facing an uphill battle.

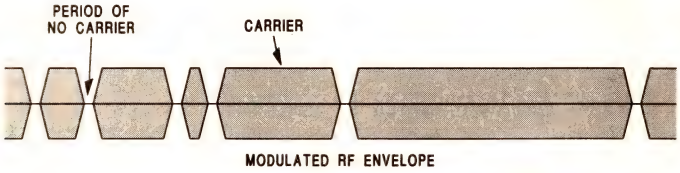


Fig.1: a typical modulation pattern from an AM transmitter. Note that the modulation is completely blocked off for 350µs at regular intervals & this will result in an erroneous reading if you try to measure the carrier frequency using a DFM.

To start with, and this applies for both AM and FM systems, check that the transmitter is working. For those with little equipment, placing the transmitter close to a TV receiver will usually result in a series of bars on the TV screen. This indicates that the transmitter modulation is OK and that the transmitter is radiating. Moving the controls will often result in a change in the bar pattern.

A better test, is of course, to use a second receiver which can also be used for voltage comparisons.

For those with an oscilloscope, testing an AM transmitter is fairly easy. First, clip the ground lead to the probe tip to make a sniffer loop, then hold the loop near the Tx antenna or, better still, slip it over the antenna. Now, turn up the scope's sensitivity until a modulation pattern begins to appear on the screen. This will appear as a thick green line, blocked off into 100% modulated blocks – see Fig.1.

The effectiveness of this test will depend upon many factors, the prime one being the frequency response of the oscilloscope. Often, even a poor scope will show some low level RF on the screen – enough to determine that the transmitter is working correctly.

The FM transmitter presents more of a problem. The TV test may work and the second receiver certainly will. For those with test equipment, a scanning receiver, an RF test set or a modulation meter will suffice to establish that RF and modulation are present and that the transmitter is working to some degree.

Note that, for this series of articles, I am going to ignore the spectrum analyser on two counts. First, so few people have one of these devices that they may be discounted as far as most readers are concerned. And second, anyone with one of these devices probably has little need of instruction in how to use it.

Having established that the transmitter is radiating, the next step is to establish the operating frequency. Most sets have plug-in crystals or modules these days and the number

times I have received transmitters with the wrong ystal in the socket is beyond my recall.

Here, AM presents a real problem and FM is the easy ıe. Any frequency counter will just simply read off e carrier frequency if a sniffer probe is held in close oximity to the transmitter antenna. Be careful, though move the transmitter just close enough to the test uipment to give a reliable reading. You can overload ıput stages and damage them if you stick the Tx ntenna right down the poor thing's throat.

Because the carrier in an AM transmitter is blocked ff for 350µs every 1-2ms, a frequency meter will give ıe incorrect frequency. The actual variation will de- end on the counting period and the point at which the ount started. Thus, unless the frequency counter can tart and stop in less than 1ms, the chances are that you vill get an incorrect count.

Counters such as this are not easy to come by and I ıave finally located one just recently after years of earching. So unless you have such a frequency coun- er, the best bet is a scanning receiver which shows the carrier frequency on the display. If you have a scanning receiver, just tune for maximum RSSI (received signal strength indication) – or noise if your receiver has no signal strength meter – and read off the frequency from the display.

Check the crystal

If you have no equipment, then you are on your own and all I can suggest is that you check that the crystal is

"The number of times I have received transmitters with the wrong crystal in the socket is beyond my recall".

the correct one. Be aware that some modellers accidentally put the receiver crystal in the transmitter and vice-versa. This may result in a loss of range or a complete loss of signal if the receiver has another correct receiver crystal in it.

A tricky problem here is that occasionally I have found crystals which have either gone off frequency or were incorrectly marked during manufacture. If in doubt, heavy some friend or acquaintance, or even the local serviceman, into checking the crystals for you.

At Silvertone, I have a dedicated RF generator which we built many years ago. This is fitted with a 100dB stepped attenuator, switched crystals for all model bands, a crystal socket, an inbuilt 8-channel pulse width encoder complete with pot for operating the channel one servo, and a BNC connector and modulation kill switch for checking the crystal frequency. The output stage is fitted with a signal level meter which doubles as a crystal activity checker.

Thus, for us the testing of an AM set begins with a voltage and field strength test on the transmitter, frequency count on the Tx crystal, modulation and purity checks of the RF sinewave on a 50MHz scope, and

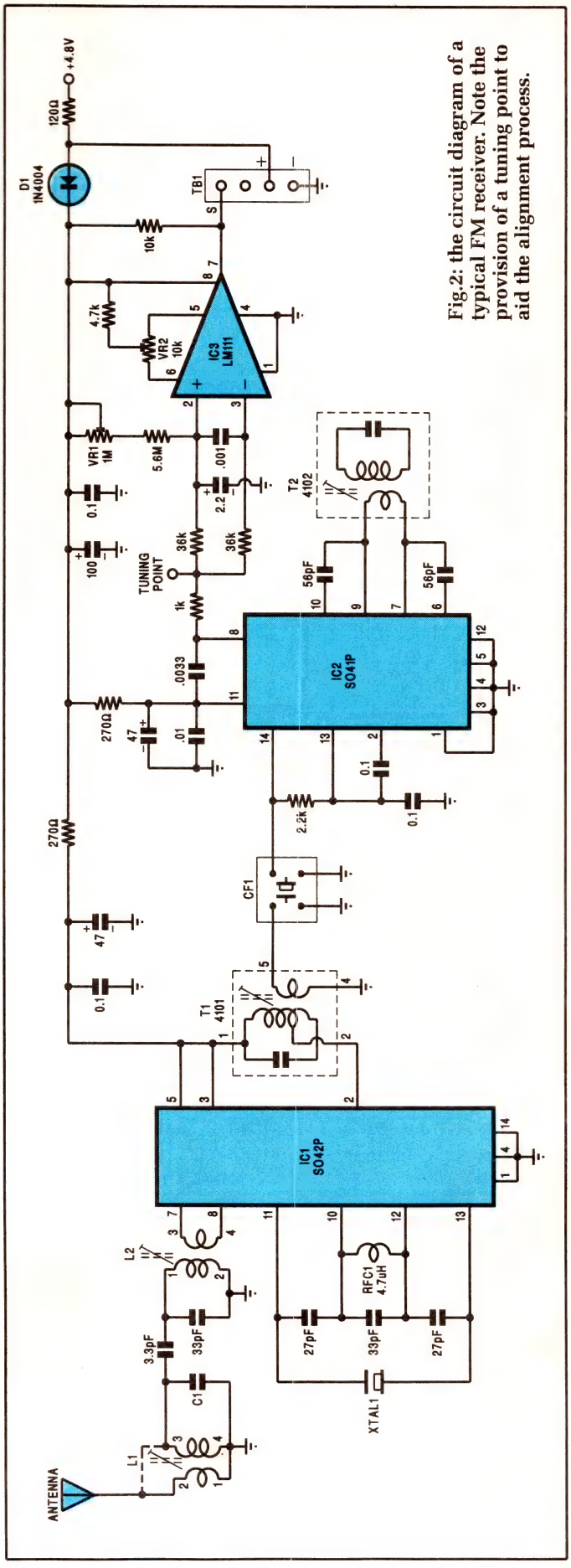


Fig.2: the circuit diagram of a typical FM receiver. Note the provision of a tuning point to aid the alignment process.

harmonic content checks on a spectrum analyser. The Tx crystal is then tested for activity if the Tx output appears to be on the low side. We then move onto a full visual inspection and more detailed work if required.

For FM sets, a modulation meter is added to the above tests. This will give the frequency deviation and the demodulated audio waveform. I always check to see that the AM content of the modulation is within reasonable limits. Some FM sets have a very high AM content in their modulation.

Receiver checks

At long last we are ready to move on to receiver testing. Begin with the mechanical inspection and testing as outlined in the last two issues. Do a physical examination of the receiver battery and check the terminal voltage of each cell. All should be approximately equal.

Next, test the receiver battery at the socket for no-load voltage. This should be about 5V. Some car sets are now running anything up to 7.2V for the higher-powered servos so be aware of this variation. Now plug the whole system together and switch on. Check the battery voltage again under load – this should not be below about 1.1V per cell.

If it is lower than this, then recharge the battery. If there are cells which are below 1.25V after charging, then dump the pack. The load should be all servos plugged in, Tx and Rx switched on and no servos operating. With all servos operating, the voltage may drop as low as 1.1V depending on a range of factors, including the servo current, number of servos and internal condition of the batteries.

At Silvertone, we use a cycling graphic analysis system and the batteries are placed under a 270mA load which gives approximately a 2-hour trace for a normal battery. A cycling battery charger is very handy for this type of testing and will give a very good indication of battery capacity.

If you have only a voltmeter, get your friend to wriggle all of the transmitter controls briskly while you check the load voltage on the battery. The cells should not drop below 1.1V each under full load.

Now measure the voltage at the point where the battery supply comes into the PC board. If you have voltage there and still no servo operation, then you really do have a problem. Fig.2 shows the circuit diagram of a typical FM receiver.

At this point, I usually check the activity of the receiver crystal and its frequency, as it is easily and often broken in a crash and it is easy to remove and test. If this is OK, I then move on to a full voltage test on the PC board using the scope.

Starting at the crystal oscillator, check that the oscillator is running and giving a reasonable level of RF output. Next, check to see that all of the RF and IF coils are continuous, by using a voltage test where DC is applied or a continuity test where there is no DC as in the front-end RF coils.

"I usually check the activity of the receiver crystal and its frequency, as it is easily and often broken in a crash. It is easy to remove and test".

Coils are often broken in a crash and go open circuit. One point here is that when re-tuning the receiver, stay alert for signs of internal damage to coils and crystals. A large shift in the position of the slug in any tuning coil often indicates a broken coil. Replace the coil as a precaution. Remember always that the key element in servicing model aircraft equipment is prevention and any suspicion should be acted upon.

If you have worked your way through the receiver to the detector and you finally have audio, you are past most of the fragile bits. From here on, it is generally routine servicing and the fault is usually visible cra damage.

I have not gone into the complexi of every type of circuit, as there a too many for the space allowed. I stead, I have briefly covered the spe ialised areas which are peculiar R/C servicing.

Receiver tuning

Finally, just a word or two on tur ing the receiver. Before doing thi unplug all servos and, if you are usin the transmitter, remove its antenn (warning: do not let the Tx run for to long in this condition as the outpu transistor may overheat and suffe damage).

In an AM Rx, there are two mair types of detectors: (1) the simple di ode detector; and (2) the transistor ised version of the old "anode bend' detector. When tuning receivers with a diode detector, connect the negative lead of a voltmeter to the diode output and the positive lead of the meter to ground. When power is applied, the meter will read a small reverse voltage until the transmitter is turned on, at which point it will rise to about 0.6V or 0.7V, depending on the signal level and tuning.

Reduce the signal level by moving the transmitter away or reducing the signal generator output until the voltmeter reads approximately 0V. In other words, tune at the lowest signal level you can read on the meter.

Starting at the antenna coil, tune for maximum voltage and progress along the chain. When you get to the oscillator coil, this will tune to a peak and drop off slowly on one side and abruptly on the other. Tune into the abrupt side until the oscillation stops, then back out to the peak. When the oscillator starts again, continue in the peak direction for a full turn. That is the final setting.

There is one problem with tuning the receiver this way, due to the fact that some receivers have a wave-trap in the input stage to suppress unwanted input signals. Unless you know the tuning specification and set-up procedure, there is little that can be done about tuning this wave-trap correctly. The main thing is to be aware of the situation.

Tune the IF coils in the normal manner, firstly for peak voltage, then if a scope is available, for wave shape. Be sure to keep the signal level at the

west level possible at all times, by nstantly reducing the signal gen-ator output or moving the Tx fur-er away.

Run through the complete set of oils again once the Rx is tuned to nsure that there is no interaction be-veen coils.

ctive detector

Tuning an active detector is quite ne opposite. In this case, the meter is ooked up with its negative lead to round, while its positive lead goes to he tuning point (ie, the collector of he detector transistor). In a well hought out receiver, such as Silver-one, Futaba and some other Japanese eceivers, the detector is clearly iden-ified and a specially shaped resistor s provided to hook the meter or scope robe onto.

In a really civilized receiver, the hird pin on the battery connector will be arranged as the detector tuning point. Unfortunately, in the majority of cases, there is no thought given to the tuning and it is almost impossible to hang a lead on some receivers.

When the receiver is switched on and the Tx is off, the active detector will read about 4V. This will drop to about 1.5-2V when the Tx is subse-quently switched on. Tune for the maximum dip in voltage and trim the IF for wave shape (always at the low-est level of signal).

FM receiver tuning

FM receivers usually use a quad-rature coil or ceramic filter as an au-dio detector. Hook the scope to a suit-able point and tune for maximum au-dio, again trimming the IF coil(s) for wave shape. Again, keep that RF sig-nal level to a minimum.

One interesting point with an FM receiver is that if the quadrature coil is tuned to the wrong side of the car-rier, the audio will appear in an in-verted form. This is the reason why it is difficult to change some overseas FM sets which come in on 27-29MHz. The overseas 27MHz sets use a low side receiver crystal while in Aus-tralia, we use a high side receiver crystal. Thus, using a standard Aus-tralian crystal pair will invert the au-dio and the set will not work. The answer is an especially cut receiver crystal on the low side of the carrier.

That's it for this month. Next month, we'll look at servos. **SC**

SILICON CHIP BINDERS

These beautifully-made binders will protect your copies of SILICON CHIP. They feature heavy-board covers and are made from a distinctive 2-tone green vinyl that will look great on your bookshelf.

- ★ High quality.
- ★ Hold up to 14 issues (12 issues plus catalogs)
- ★ 80mm internal width.
- ★ SILICON CHIP logo printed in gold-coloured lettering on the spine & cover.

Yes! Please send me _____ SILICON CHIP binder(s) at $A14.95 each (incl. postage in Australia). NZ & PNG orders please add $5 each for postage. Not available elsewhere.

Enclosed is my cheque/money order for $_____ or please debit my

❑ Bankcard ❑ Visa Card ❑ Master Card

Card No. | | | | | | | | | | | | | | | |

Signature_____ Card expiry date_____/_____

Name _____

Street _____

Suburb/town _____ Postcode_____

SILICON CHIP PUBLICATIONS
PO Box 139, Collaroy, NSW 2097, Australia.
Phone (02) 979 5644 Fax: (02) 979 6503.

ROD IRVING ELECTRONICS

PRINTER RIBBONS GALORE

PRINTER MODEL	Cat No.	1-9	10+
ADMATE D.P.80	C21238	$13.95	$11.95
BROTHER AX10/40	C21240	$9.95	$8.95
BROTHER CM/EM	C21242	$11.95	$9.95
BROTHER 1509 / CENTRONICS 220	C21208	$14.95	$12.95
BROTHER 1824L	C21236	$19.95	$17.95
BURROUGHS B.300	C21244	$24.95	$22.45
CANON AP100/150	C21246	$9.95	$8.95
CANON AP11 200/400	C21248	$9.95	$8.95
CANON 1080 / 1156A, H80, A40	C22005	$14.95	$12.95
CANON A40 / A50	C22039	$14.95	$12.95
EPSON LX100 RIBBON	C22000	$16.95	$14.95
2274FN EPSON ERC-03	C21252	$18.95	$17.05
EPSON LX80 GX80, LX86	C22003	$9.95	$7.95
EPSON LQ500, LQ200 LQ570, LQ850, LQ800, LQ850, LQ870, LQ400 MT82, LQ570+	C22004	$11.95	$10.95
EPSON LQ 1000 LQ1050, LQ1010, LQ1070, FX1050.	C22011	$11.95	$9.95
EPSON LQ1500	C22009	$14.95	$11.95
EPSON EX800	C21216	$18.95	$16.95
EPSON LQ2550	C21218	$18.95	$16.95
EPSON ERC23	C21222	$18.95	$16.95
EPSON DFX5000	C21234	$39.95	$35.95
EPSON LQ100	C21200	$14.95	$12.95
MX 100, FX100, RX 100, LX 1000	C22002	$12.95	$10.95
CP80, SX80, DP80, SP80	C22036	$12.95	$10.95
MX70, MX80, FX80, RX80, FX800, LX800, LX400.	C22031	$10.95	$8.95
DIGITAL L.A 34/100	C21250	$18.95	$17.05
FUJITSU DL1100	C21254	$27.95	$25.15
FUJITSU DL3300	C21228	$18.95	$16.95
AMSTRAD DMP 2/3000	C21190	$17.95	$15.95
S2-72 COPAL RIBBON FOR KAITEC	C22038	$19.95	$18.95
COMMODORE 4023/698	C21180	$12.95	$10.95
CITIZEN 200 & 140 COLOUR RIBBON	C21114	$29.95	$27.96
CITIZEN 200 & 140 BLACK RIBBON	C21116	$16.95	$14.95
CITIZEN PN48 S/STRIKE	C22201	$16.95	$14.95
CITIZEN 120D	C21210	$10.95	$9.95
SEIKOSHA SP800/1000 AMSTRAD PCW8256	C21212	$18.95	$16.95
SEIKOSHA BP5420	C21204	$19.95	$17.95
STAR NL10 / NX10	C21214	$18.95	$16.95
STAR NR/NX 15 STAR NB10	C21220	$18.95	$16.95
STAR NX 1000	C22048	$11.95	$10.95
STAR NX 1000C COLOUR	C22040	$29.95	$26.95
STAR NX 1500, STAR LC 2410, STAR NX 2410, IBM 5538.	C22047	$14.95	$12.95
HEWLETT/PACKARD 2235 RUG WRITER	C21230	$29.95	$26.95
NEC PINWRITER P3,P7	C21202	$17.95	$15.95
NEC PINWRITER P5	C21206	$18.95	$16.95
NEC P6 PLUS, P7 PLUS NEC P5300	C21232	$18.95	$16.95
NEC PINWRITER P3200/3300	C21262	$24.95	$22.45
TOSHIBA P1350	C22027	$23.95	$22.95
TOSHIBA P321/341	C21226	$18.95	$16.95
2746MS NAKAJIMA AX200 240	C21256	$18.95	$17.05
NATIONAL PANASONIC KXP 1080 / 1081 / 1082 KXM110, SUPER 5	C22034	$11.95	$10.95
NATIONAL PANASONIC KXP1124/KXP1180	C22024	$19.95	$17.95
NATIONAL PANASONIC KXP 1540 1580	C21258	$22.95	$20.65
NAKAJIMA AX200 240	C21256	$18.95	$17.05
APPLE IMAGE WRITER			
CITOH 8510 - 1550	C22051	$13.95	$12.50
QUME IV MULTI-STRIKE	C22023	$14.95	$13.95
RDC DIABLO HYTYPE II FILM	C22021	$10.95	$9.95
SAMSUNG SP0912/2412	C21266	$18.95	$17.05
SAMSUNG SP2421	C21270	$29.95	$26.95
1060FN PRINTRONICS P300, 600 SPOOL	C21260	$29.95	$26.95
2237FN DIGITAL L.A 34/100	C21250	$18.95	$17.05
OKI MICROLINE 393	C21224	$39.95	$35.95
OKI 172	C21104	$12.95	$11.95
OKI 380/390	C21105	$14.95	$12.95
OKI LASER 400/800 TONER CARTRIDGE	C21106	$59.95	$54.95
EPSON INK CARTRIDGE SO20010 FOR EPSON SQ870/1170 INK CARTRIDGEC92100		$51.00	

NEW COMPUTER BOOKS & MANUALS

Cat No.	Title	Price
B21400	USING VISUAL BASIC 3	$61.95
B21401	USING PAGEMAKER 5	$61.95
B21402	USING WORD FOR WINDOWS 6	$59.95
B21403	USING WORDPERFECT6 FOR WINDOWS	$65.95
B21404	USING CORELDRAW VERSION 4	$59.95
B21405	USING EXCEL 5 FOR WINDOWS 5th EDITION	$61.95
B21406	USING MS DOS 6.2	$65.95
B22024	FIRST BOOK OF WORDPERFECT6 FOR WINDOWS	$37.95
B24317	QUICK REFERENCE FOR LOTUS IMPROV FOR WINDOWS	$19.95
B24319	WORD FOR WINDOWS 6 QUICK REFERENCE	$19.95
B24321	QUICK REFERENCE EXCEL 5 FOR WINDOWS	$19.95
B24322	MS DOS 6.2 QUICK REFERENCE	$21.95
B23213	10 MINUTE WORD FOR WINDOWS NEW EDITION	$22.95
B24314	10 MINUTE GUIDE TO EXCEL 5	$19.95
B24315	10 MINUTE GUIDE TO MS 6.2	$19.95
B24203	TEACH YOURSELF WINDOWS PROGRAMMING IN 21 DAYS	$51.95
B24202	TEACH YOURSELF C IN 21 DAYS	$51.95

NEW ELECTRONIC BOOKS

DIGITAL ELECTRONICS

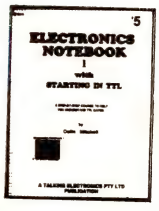
THIS BOOK IS THE COMPLETION OF THE 10 MINUTE DIGITAL COURSE FROM TALKING ELECTRONICS, ISSUES 1 TO 14. YOU CAN APPROACH THIS BOOK IN TWO WAYS. IT CAN BE READ AS A NOVEL FROM COVER TO COVER, OR USED AS A TEXT BOOK FOR QUICK REFERENCING.

B10045.....$5.00

ELECTRONICS NOTEBOOK 1

THIS BOOKS INCLUDES THE REPRINTING OF "ELECTRONICS NOTEBOOK 1" AND "STARTING IN TTL (TRANSISOR-TRANSISTOR-LOGIC)" IT GIVES A STEP-BY-STEP COURSE TO HELP YOU UNDERSTAND TTL GATES AND COMPONENTS, THIS BOOK IS A MUST FOR ANY BEGGINER OR STUDENT.

B10046.....$5.00



SMART SECURITY DEVICES 1

IN THIS BOOK THERE IS A RANGE OF SMART DEVICES FOR SECURITY AND SURVEILLANCE. THIS BOOK IS VERY EASY TO FOLLOW WITH STEP BY STEP INSTRUCTIONS.

B10047.....$3.60

FREE PACK AND POST FOR ORDERS OVER $25.00 OFFER EXPIRES 31/1/94

ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS

ROD IRVING ELECTRONICS

100% AUSTRALIA OWNED. EST: 1977

MONITORS

- 14" SUPER VGA.....$399
  1024 x 768, (0.28" Dot Pitch)
- 14" NON-INTERLACED...$479
  1024 x 768, (0.28" Dot Pitch)
- 15" XGA.....$729
  1280 x 1024, Digital

FLOPPY DRIVES

FLOPPY DISK DRIVES

1.44 Mb 3½" F.D.D.	$79.00
1.2 Mb 5¼" F.D.D.	$89.00
3½" F.D.D. CRADLE	$9.95

PRINTER SWITCHES

2 WAY DB25 PIN	$29.95
4 WAY DB25 PIN	$39.95
2 WAY CENTRONICS	$34.95
4 WAY CENTRONICS	$49.95

EPSON PRINTERS

EPL 5200 $1299.00

*Laser *6p.p.m. *300 dpi
*Expandable memory up to 5Mb
*14 Bitmapped & 13 Scalable fonts

STYLUS 800 $599.00

Epsons new Ink Jet technology delivers 360 x 360 dpi text and graphics * 9 standard fonts
* 48-nozzle Ink Jet dot matrix
* 180 cps LQ (12cpi)
* Parallel port standard.

COME INTO OUR CITY STORE FOR A FREE DEMONSTRATION OF THESE PRINTERS

MOTHERBOARDS

386SX-41 LM 47	$169
386DX-40 128K Cache	$249
NEW 386DX-40 128K Cache & Upgradable CPU socket and Local Bus Slot	$349
486DX-33 256K Cache with upgradeable CPU socket and 3 Local Bus Slot	$795
486DX2-50 256K Cache L.B	$895
486DX-50 256K Cache L.B	$1095
486DX2-66 256K Cache L.B	$1195

FREE PACK & POST FOR ORDERS OVER $25.00 OFFER EXPIRES MIDNIGHT 31/1/94.

MULTIMEDIA PRODUCTS

SOUND BLASTER DELUXE	$99
SOUND BLASTER PRO	$199
SOUND BLASTER 16 BIT ASP	$449
MIDI BLASTER	$385
WAVE BLASTER	$399
VIDEO BLASTER	$649
SPEAKERS TO SUIT, ONLY	$10

SOUND BLASTER MULTIMEDIA PACKAGES

PERFORMANCE PACK..... $899
5 CD's, S'Blaster 16, Dual Speed CD ROM, Speakers, Microphone, VRS.

PREMIUM PACK..... $1099
8 CD's, S'Blaster 16, Dual Speed CD ROM, Speakers, Mic, Voice Assist.

DISCOVERY PACK..... $699
4 CD's, S'Blaster Pro V2, Dual Speed CD ROM, Speakers.

MATH COPROCESSORS

387SX/SL	$179	387DX	$189
387DX-40	$179	387SX-40	$179

JOYSTICKS

QS - 123 WARRIOR 5 $39.95
IBM Compatible (15 pin)
QS - 133 $39.95
APPLE & IBM Compatible (9 & 15 pin)
AVIATOR 5 $79.95
*Authentic aircraft control yoke
*Automatic control yoke centering
*Realistic Altitude / Level Indicator
386 & 486 machines require additional game card.....$19.95

IBM CARDS

LOCAL BUS VESA STANDARD

Super I/O Card	$120
1 Meg VGA Western Digital	$199
1 Meg VGA Oak	$129
Cirrus Logic 1 Meg	$149
Parradise Accelerator LB	$355

16 BIT CARDS

Ethernet (NE2000)	$295
Turbo Accelerator (Paradise)	$185
Cirrus S3 VGA	$199
1 Meg Trident 8900CL	$149
IDE Paddle and SPG cards	$49

8 BIT CARDS

2 Port serial card	$39
Clock card	$29
Game Card	$29
2 Way F.D.D. controller	$49
Ethernet (NE1000)	$235

STUDENT SOFTWARE

WINDOWS BASED STUDENT SOFTWARE

	STUDENT	FULL
Lotus 123 V4	$179	$580
Lotus Freelance V2	$179	$580
MS Powerpoint	$230	$595
MS Project	$340	$880
MS Publisher	$110	$295
MS Works	$99	$250
Norton Back-up	$99	$250
Norton Desktop	$155	$250
Quattro Pro V1	$99	$550
WordPerfect 5.2	$189	$525

STUDENT IDENTIFICATION MUST BE PRODUCED WHEN ORDERING AT THE STUDENT PRICE

VERBATIM DISKS

PLASTIC BOXES

Description	1-9	10+
3½ DS/DD	$18.95	$17.95
3½ DS/HD	$28.95	$26.95
5¼ DS/DD	$13.95	$12.95
5¼ DS/HD	$18.95	$17.95

CARDBOARD BOXES

Description	1-9	10+
3½ DS/DD	$17.95	$16.95
3½ DS/HD	$27.95	$25.95
5¼ DS/DD	$12.95	$11.95
5¼ DS/HD	$17.95	$16.95

SIMMS

DESCRIPTION	1-9	25+	100+
1M x 9-60	$99	$95	$89
1M x 9-70	$85	$83	$79
4M x 9-70	$299	$295	$289
4M x 9-60	$339	$329	$319

GIFT VOUCHERS AVAILABLE
FREE 148 PAGE CATALOGUE
Come in & pick one up!

MAESTRO MODEMS

96M (ext) 9,600 baud, error correction, data compression
X19007.....$499

144M (ext) 14,400 baud, error correction, data compression
X19002.....$549

FAX MODEMS

RC224FM (internal) Card modem 2,400 baud data - 9,600 baud (send only) Fax.
X18990.....$249

9600XR (ext) 2,400 baud data - 9,600 baud send / receive Fax.
X19008.....$399

96FM (ext) 9,600 baud data - 9,600 baud send / receive Fax.
X18996.....$549

144FM (ext) 14,400 baud data - 14,400 baud send / receive Fax.
X19005.....$599

All modems contain Quicklink II software. Fax Modems also contain Quicklink II fax software.

SCANNERS

GENIUS SCANNER 4500

Black, white and grey emulation scanner with powerful photo / image editor and multilingual omnifont OCR. $199.00

HARD DRIVES

VOICE COIL IDE HARD DRIVES

Cap	Av.Access	Tax Inc.	Tax Ex.
131M	16ms	$349	$288
212M	16ms	$379	$310
260M	16ms	$459	$379
345M	12ms	$525	$435
420M	12ms	$699	$577
540M	12ms	$799	$660

BOX HILL STORE NOW OPEN 9 - 3P.M SATURDAY.

BULK DISK PRICES

DESCRIPTION	1-9	10+	50+	100+	500+
5¼ DS/DD	$4.50	$4.30	$4.30	$4.30	$3.95
5¼ DS/HD	$8.50	$7.95	$7.90	$6.90	$6.90
3½ DS/DD	$8.50	$7.95	$7.90	$6.90	$6.90
3½ DS/HD	$10.50	$9.95	$9.75	$8.95	$8.50

All disks come with Write Protects and envelopes and a life time warranty.

COMPUTER SYSTEMS • Four Year Parts & Labour Warranty

386SX 40	386DX 40	386DX 40 Local Bus	486DX 33	486DX2 50	486DX 50	486DX2 66
$1215	$1295	$1395	$1725	$1852	$2020	$2120
Tax Inc $1470	Tax Inc $1565	Tax Inc $1669	Tax Inc $2089	Tax Inc $2240	Tax Inc $2440	Tax Inc $2570

ALL SYSTEMS INCLUDE 212 MEG HARD DISK - 4 MEG RAM - 101 KEYBOARD - SUPER VGA (1024 X 768) (0.28" DOT PITCH) COLOUR MONITOR - 2 SPG PORTS - 1 MEG VGA CARD 1.44 MEG 3½" OR 1.2 5 ¼" FLOPPY DISK DRIVE - 3 SLOT VESA LOCAL BUS MOTHERBOARD & VESA LOCAL BUS 1M VGA CARDS ARE SUPPLIED IN 486 MACHINES AT NO EXTRA COST (Up to 1280 x 1024 Resolution) •All 486 motherboards are supplied with Chipaway Anti Virus BIOS Lock and Utilities

ROD IRVING ELECTRONICS Pty. Ltd.

FOR THE SERIOUS COMPUTER USER Est. 1977

MELBOURNE: 48 A'Beckett St. City. Ph:(03) 663 6151. Computers (03) 639 1640
OAKLEIGH: 240c Huntingdale Rd. Oakleigh. Ph: (03) 562 8939. Fax:(03) 562 8940
NORTHCOTE: 423 High St. Northcote. Ph: (03) 489 8866. Fax:(03) 489 8131
BOX HILL: 1031 Maroondah Hwy. Box Hill. Ph: (03) 899 6033. Fax:(03) 899 0156
ADELAIDE: 241-243 Wright St. Adelaide. Ph. (08) 211 7200. Fax:(08) 211 7273
SYDNEY: 74 Parramatta Rd. Stanmore Ph: (02) 519 3888. Fax:(02) 516 5024
HEAD OFFICE: 56 Renver Rd Clayton, Victoria, 3168 Ph: (03) 543 7877
BLUESTAR COMPUTERS: 271 Maroondah Hwy. Ringwood Ph: (03) 870 1800

TRADING HOURS: Mon / Fri 9am - 5.30pm.Sat 9am - 1pm

FREE CATALOGUE

DOS 6.00 UPGRADE just $59.00 Only 10 left.

DOS 6.2 UPGRADE Full Version. The best version of DOS yet. Offering features which protect your Data, free up more memory and extra double space enhancements..Just $99.00

DOS 6.2 STEPUP Upgrades your DOS 6.0 to 6.2 Only $22.00

Tax Exempt sales to:
RITRONICS WHOLESALE Ph. (03) 543 2166 Fax. (03) 543 2648
MAIL ORDER: Ph:(03) 543 7877 Fax:(03) 543 8295
Mail Order Hotline 1800 33 5757
Order from home through our Bulletin Board on (03) 562 7877

Errors and Omissions excepted. Prices subject to change without notice due to RAM CPU price availability fluctuations. IBM*, PC*, Microsoft* are all registered trademarks of their respective owners. Valid from 11 93

FREE PACK AND POST FOR ORDERS OVER $25.00. OFFER EXPIRES MIDNIGHT 31/1/94.

ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS

ROD IRVING ELECTRONICS

ROD IRVING ELECTRONICS
For the Latest Products & competitive prices!

VESA I/O LOCAL BUS CARD

NEW

A high performance , low cost and highly integrated fully static logic design for IDE hard disk applications. It provides a data path and control interface beween standard IDE drives and a 486, 386 local bus. It is fully compatible with the ANSI ATA revision 3.0 specifications for IDE hard disk operation, and the VESA VL-Bus revision 1.0specifcation for local budd PC devices.

FEATURES:

- A high performance solution packaged in a 100-pin PQFP
- User less board space than descrete TTL design
- VESA VL Bus Rev 1.0 compatible, connects directly to local bus CPU chips.
- Supports 32 bit data transfer
- Zero wait state writes operation
- Direct interface to various type of drives that are ANSI ATA compatible
- Programmable command active and cycle times
- Independent command block register and data register access timing
- Supports primary and secondary disk controller selection
- Fully supported with reference design schematics, driver application notes and engineering services.

.....$99.00

QUICKSHOT STARFIGHTER 5

THE LATEST IN JOYSTICKS

FEATURES:

- **NEW DIGITAL DESIGN**
- **NO TRIMMER REQUIRED**
- **IBM PC/XT/AT/386/486 COMPATIBLE**
- **AUTOMATIC CENTERING WITHOUT ADJUSTMENT**
- **TWO FIRE BUTTONS**
- **TURBO FIRE SELECTOR**
- **6-FOOT CABLE WITH 15-PIN CONNECTOR**

C14280.....$39.95

D SIZE NICAD BATTERIES

Spending heaps on batteries for the kids christmas toys? Well save dollars on these D size Nicads.

Nominal Voltage: 1.2V 1,200mAH

Charging: 120mA, 15hrs

S15022 Were $9.95 each

1-9	10+
Sale Price: $5.95	**$4.95**

QUICKSHOT SPEAKERS

STEREO SPEAKER SYSTEM

- Magnetically sheilded, safe for placing next to monitor
- 2W + 2W Music Power
- Also ideal for use with personal cassette and CD player
- Frequency Response: 100-15,000HZ

C10784.....$29.95

HP 51626A PRINT CARTRIDGE

TWICE THE INK

TWICE THE LIFE

HEWLETT PACKARD HP 51626A PRINT CARTRIDGE

A high capacity print cartridge for letter quality text and graphics. Twice the capacity of the 51608A print cartridge.

SUITS:

DeskJet, DeskJet PLUS, DeskJet 500 DeskJet 500C, DeskJet 500J, DeskJet 505J, DeskWriter C, DesignJet, DesignJet 600, Fax-200, Fax-300, Fax-310.

C94020.....$65.95

MAGIC EYES

Hands Free Light

Brilliant idea. Hands free light where you want it. You don't have to take off your glasses. Great for checking circuit boards, inside dark places, motorcycle repairs, camping, fishing and thousands of other uses when you need light where you are looking and youneed to use both hands.

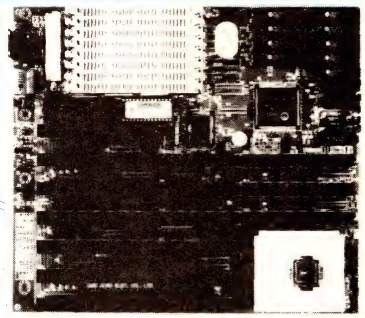
Uses 4 AAA batteries (Not included)

Was $19.95

Sale price just $12.95

FREE PACK & POST FOR ORDERS OVER $25.00. OFFER EXPIRES 31/1/94.

SJ-486VESA-3VL MOTHERBOARD



This 486DX board is IBM PC/AT compatible for high performance. Built with exquisite cache controller in advance 1.0 um CMOS technology, UM82C491 (Integrated Memory Controller, IMC Integrated System Controller ISC) with UM82C493.

Features:

Board Specification

- Ram socket: 2 bank (0,1) 30 Pin Simm Socket
- Slot: ISA (16bit)....3
  ISA (8 bit) ...1
  ISA + VESA...3
- Chip Set: UMC 82C491, 82C493
- Cache Ram: 32 -256KB
- CPU TYPE: PGA type
- Support 80486DX CPU running at 25/33/40/50MHz
- Support 80486DX2 cpu running at 25/33/40/50Mhz
- Support 80486SX CPU running at 16/20/25Mhz
- Support 3 (tree) Vesa Local Bus
- Support Master mode and Slave mode
- Support 486DX 50MHz 486 DX2 66MHz
- Built-in cache controller
  - Direct Mapped organization with write back operation
  - Programmable 80486 read hit wait state for burst mode
    (2-1-1-1, 3-1-1-1-, 3-2-2-2)
  -) wait state for cache hit
  -Flexible cage size: 32/64/128/256 KB
  -Slow hidden DRAM refresh to boost system performance
  - Built-in registers to support three independent non-cacheable regions
  - Support cache line fill as well as 80486 burst mode
  - Support automatic memory size detection
- Sophisticated DRAM controller
  -Support fast / Standard page mode
  - Support 4 banks (on board 0,1 bank) CPU speed DRAM with memory size up to 64MB
  - Support mixable 256kx9 - 1M x 9, 1M x 9 - 4M x 9, DRAM modules
  - Programmable DRAM wait states
  - Support 256KB or 384KB (A to F segments of first 1MB) relocation to the top of DRAM memory
- Support Shadow RAM for video and system BIOS
  (C,F, segments)
- Support fast GATE A20 and fast CPU RESET to optimize OS/2 operations
- Synchronous AT bus clock with programmable clock
- Support for all current 486 CPUs as well as future CPU up grades using a 238-Pin ZIF (Zero Insertion Force) socket.

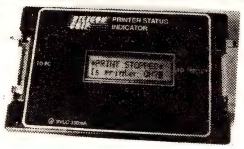
.....$249.00*

(*Price does not include CPU.)

ROD IRVING ELECTRONICS

FREE PACK & POST FOR ORDERS OVER $25.00. OFFER EXPIRES MIDNIGHT 31/1/93.

MORE GREAT KITS TO BUILD OVER SUMMER!



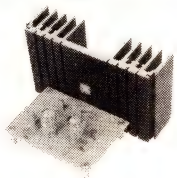
A PRINTER STATUS INDICATOR FOR PCs

This great device indicates any errors that may occur in transmission while sending files down your printer cable. When it comes to printing files, most programs these days leave you flat if something goes wrong while the file is being sent to the printer. And while many graphic print files exceeding 3 and 4 MB, it can be extremely annoying when after sitting around for 5 to 10 minutes or so, nothing happens.

The Printer Status Indicator won't prevent errors from occurring but it will notify you as soon as they happen.

Silicon Chip Jan'94

K10455.....$65.95



A LOW COST 25W AMPLIFIER MODULE

Looking for a low cost audio power module that's easy to assemble? This compact module will deliver 25W RMS into an 8-ohm load and can be powered from single or dual supply rails.

As power amplifier modules go, this unit may not rank at the top for raw power but you'll be hard pressed to find a simpler or more versatile circuit. It's based on a single IC, the LM1875T 20W audio amplifier from National Semiconductor. This IC comes in a TO-220 package and combined with a suitable power supply, delivers 25W RMS into 8 ohms and 20W RMS into 4ohms.

Silicon Chip Dec '93

K10465.....$18.95

VERSATILE 40V/3A LAB POWER SUPPLY - 1

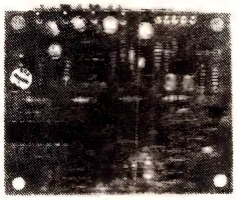
This new supply should handle all but the most specialised tasks on a home or professional workbench. Based on readily available components, it has full electrical and thermal overload protection, adjustable current limiting, dual meters and can be used as either a single or dual-tracking supply.

FEATURES:

Single or dual tracking operation
Variable current limiting in two ranges
Individual Volts and Amps meters
Over temperature shutdown
Output load switching
Current setting switch
Fully floating circuit with separate earth terminal
Dropout (output ripple) indicator.

EA Dec '93

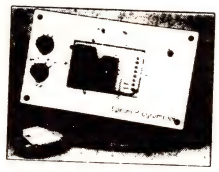
K10460.....$165.95



IMPROVED DECODER FOR ACS SIGNALS - 1

As you may well be aware, many Australian FM broadcasters are radiating either one or two "piggyback" ACS (Ancillary Communication Services) subcarrier signals in addition to their own main programme. To listen to these "hidden signals" all you need to do is fit your FM receiver with ACS decoder. Be able to hear such things as background music used in shopping centres, supermarkets, offices etc. Some organizations use the ACS system to broadcast such programs as news and special interest/foreign language material. These can also be picked up on radios fitted with ACS decoders EA SEPT '93.

K10445.....$19.95

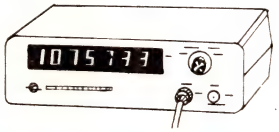


PC-CONTROLLED EPROM PROGRAMMER

Experimenting with microprocessors is great fun, but it can be a lot easier and more productive with a few specialised pieces of equipment. One of these valuable extras is an EPROM programmer which is very flexible and is controlled from a standard PC printer port. As well as programming EPROMs it also has a read back feature. Commercially available programmers start around $250.00 but this project is designed to be inexpensive yet be a reasonably powerful and flexible programmer.

EA Sept-Oct. '93.

K10415.....$98.95



1GHz FREQUENCY COUNTER

Did you look at the latest 50MHz frequency counter design longingly (because of its low cost), but finally decide against it, because you either need more resolution and/or operation at higher frequencies? Well here's its big brother of that design, offering seven digits of resolution and operation up to 1GHz. Despite this higher performance the emphasis is still on good value for money - in-fact there probably isn't a cheaper way to get yourself a 1GHz frequency counter. EA April '93.

K10380.....$147.00

A SIMPLE LOW VOLTAGE SPEED CONTROLLER

If you need a low cost simple speed control or low voltage light dimmer then take a look at this little circuit. it uses just one IC and controls 12VDC motors or lights with currents up to 1 amp.

Ideal if you have something like a PCB drill and only want to run it at a few hundred revs. Save on the expense and complication of a power supply.

This kit uses the old 555 timer along with a lot of other parts you'll probably find in your junk box!

Silicon Chip Jan '94

K10450.....$13.95

CASES

WATERPROOF CLEAR TOP POLYCARBONATE INSTRUMENT BOXES

		1-9	10+
H30100	64x58x35mm	$8.95	$7.95
H30110	115x65x40mm	$11.95	$9.95
H30120	115x65x55mm	$12.95	$10.95
H30130	115x90x55mm	$14.95	$12.95
H30140	171x121x55mm	$20.95	$18.95
H30150	222x146x55mm	$24.95	$21.95

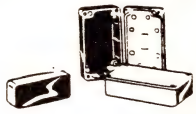
SEALED POLYCARBONATE ENCLOSURES

		1-9	10+
H30200	64x58x35mm	$4.95	$4.50
H30210	115x65x40mm	$6.95	$5.95
H30220	115x65x55mm	$8.95	$7.95
H30230	115x90x55mm	$11.95	$9.95
H30240	117x121x55mm	$19.95	$17.95
H30250	222x146x55mm	$24.95	$22.95

INSTRUMENT CASES

		1-9	10+
H30300	90x15x16mm	$4.95	$4.50
H30305	90x50x24mm	$5.95	$4.95
H30310	90x50x32mm	$6.50	$5.50
H30315	120x60x30mm	$6.95	$5.95
H30320	120x60x40mm	$7.50	$6.25
H30325	120x60x50mm	$7.95	$6.50
H30330	150x80x30mm	$8.95	$7.50
H30335	150x80x45mm	$9.95	$8.50
H30340	150x80x60mm	$11.95	$9.95
H30345	190x100x40mm	$12.95	$10.95
H30350	190x100x60mm	$14.95	$12.95
H30355	190x100x80mm	$16.95	$14.95

DIECAST BOXES



		1-9	10+
H30000	90x36x30mm	$6.75	$5.95
H30010	64x58x35mm	$6.95	$6.25
H30020	115x65x30mm	$10.95	$9.50
H30030	115x65x55mm	$12.95	$11.50
H30040	115x90x55mm	$15.95	$14.50
H30050	148x108x75mm	$27.50	$24.50
H30060	171x121x55mm	$27.95	$24.95
H30070	222x146x55mm	$29.95	$27.95

FREE PACK & POST FOR ORDERS OVER $25.00. OFFER EXPIRES MIDNIGHT 31/1/93.

ROD IRVING ELECTRONICS

USE YOUR LOGIC & SAVE "MULTI" DOLLARS ON MULTIMETERS & LOGIC PROBES

FREE PACK & POST FOR ORDERS OVER $25.00. OFFER EXPIRES MIDNIGHT 31/1/94.

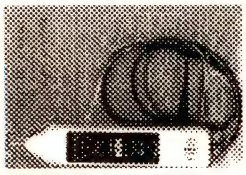
HUGE MULTIMETER SALE

SPECIAL OFFER

Buy two or more multimeters and receive an extra 10% off the price!
But Hurry stock is very limited.

Please have a second choice handy in case your first choice is unavailable.

SAVE $15

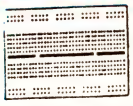


LOGIC PROBE (LP-2800)
Useful for TTL and CMOS

High & low indicators pulse memory. For the hobbiest or serious technician for tracing those hard to find faults on logic boards

Q11272 Was $29.95
Sale price $14.95

SAVE ON BREADBOARDS



100 HOLES
P11000 Was ~~$3.95~~ Sale Price $2.75

PROJECT BREAD BOARD
- 58-Group of 5 connected terminals
- 4-Bus of 25 connected Terminals

P11002 Was ~~$6.95~~ Sale Price $4.85

640 HOLES
P11005 Was ~~$10.95~~ Sale Price $7.65

640 + 100 HOLES
P11007 Was ~~$13.95~~ Sale Price $9.75

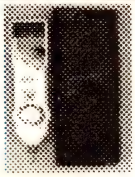
640 + 200 HOLES
P11009 Was ~~$15.95~~ Sale Price $10.70

1280 +100 HOLES
P11010 ~~$26.95~~ Sale Price $18.95

1280 + 300 HOLES
P11011 Was ~~29.95~~ Sale Price $21.00

1920 + 500 HOLES
P11015 Was ~~$59.95~~ Sale Price $41.95

SAVE $10



HUNG CHANG DIGITAL MULTIMETER HC-31

- Custom designed 80-pin LSI chip to achieve a low overall component count ensuring long term stability and accuracy.
- New LCD display with annunciators for functions, unit polarity, decimal and low battery.
- Rotary pencil type.
- Auto ranging and auto polarity.
- Convenient one hand operation by connecting the alligator clip.
- Measurement ranges (DCV,ACV resistance and continuity check, diode check).
- Data hold switch to fix he reading.

Q11270 was $49.95
Sale Price $39.95

SAVE $50

DIGITAL MULTIMETER HC-5010EC

- Display: 3½ digit
- Basic accuracy: 0.5% DC
- DC Voltage: 0-1000 Volts
- DC Current: 0-10A
- AC Voltage: 0-750 Volts
- AC Current: 0-10A
- Resistance: 0-20-M OHMS
- Capacitance: 0-20u
- Transistor: hfe gain Oof - 2000 oF
- Continuity Test, Diode test

Q13010 Was $149.00
Sale Price $99.95

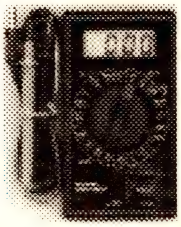
SAVE $30

DIGITAL MULTIMETER HC-4510

- Display: 4 ½ digit
- Basic Accuracy: 0.5% DC V
- DC voltage 1-1000V • DC Current: 0-10A
- AC Voltage 0-750V • AC Current: 0-10A
- Resistance: 020M ohms
- Continuity Test, Diode Test, Data Hold

Q13030 Was $149.00
Sale price: $119.00

SAVE $20



HUNG CHANG MULTI-TESTER DM301

- 3½ Digit, Basic accuracy DMM
- Low Cost, Amazing Quality, Vane pocket size.
- Safety Designed-Compiled to UL1244, VDE 0411
- Overload protection
- Diode check

SPECS:
Display: 3 ½ digit LCD. 0.5 height with polarity.
Over range Indication: 3 least significant digits blanked.
Maximum Common mode Voltage: 500V peak
Operating environment: 0 to 50° C
Power: 9V alkaline or carbon zinc cells
Dimensions: 128mm x 75 x 24mm

Q13050 Was $49.95
Sale Price: $29.95

GRAB BAGS & VALUE PACKS

$10.00 GRAB BAGS

These grab bags contain a range of components and parts from old kits, including wire and LED's ceramic trimpots from the Service Dept. and old IC's, odd fuses crystals and tantalums.

$20.00 MONSTER BAG

Same components as listed above but heaps more and more value.

ASSORTED VALUE PACKS

• .25W 1% METAL FILM PACK
• Contains: Approx. 250
R19001.....$7.95

• 25W CARBON FILM PACK
• Contains Approx: 250
R19010.....$5.95

• 50V CERAMIC PACK
• Contains Approx. 100
R19020.....$6.95

• POLYESTER CAP PACK
• Contains Approx. 50
R19030.....$6.25

• PBC ELECTRO PACK
• Contains: Approx: 50
R19040.....$6.95

DIODE PACKS

100 per pack
1N4002 (1A 200V Recifier)
Z10103.....$4.95
1N4004 (1A 400V Rectifier)
Z10106.....$5.95
1N4007 (1A 1000V Rectifier)
Z10112.....$6.95
1N914 / 1N4148
Z10135.....$3.95
1N5404 (3Amp 400V)
Z10114.....$12.95

LED MIXED PACKS
(Red only 5mm)
Approx. 100 pieces
Z10138.....$11.95

FUSE PACKS
3AG pack of 40 ($12 Value)
Contains: 4 x 500mA
8 x 1A, 6 x 1.5A, 2 x 2A, 6 x 3A, 4 x 5A, 2 x 7.5A, 4 x 10A.
S15992.....$8.95

M205 Pack of 40 ($12 Value)
Contains: 5 x 500mA, 10 x 1A, 10 x 2A, 5 x 3A, 5 x 5A, 5 x 10A,
S15994.....$8.95

MIXED IC SOCKETS
100 Units ($37.00 Value)
Contains: 15 x 8 pin, 20 x 14 pin, 10 x 16 pin, 10 x 18 pin, 5 x 20 pin, 10 x 22 pin, 5 x 24 pin, 5 x 28 pin, 10 x 40 pin,
P10546.....$24.95

FREE PACK & POST FOR ORDERS OVER $25.00. OFFER EXPIRES MIDNIGHT 31/1/94.

NICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING

ROD IRVING ELECTRONICS - WHERE YOUR DOLLAR BUYS MUCH MORE!

SPEAKER PORTING TUBE

Black plastic speaker tubes designed for finishing off breathing or porting outlets on speaker cabinets

H28640...Inside dia: 82mm, Length: 33mm.....$1.95

H28635...Inside dia: 51mm, Length: 65mm.....$1.45

PLASTIC FEET

Plastic Feet for speakers, cases, large kits etc...38cm dia. x 15 cm Pack of four.

H11862.....$3.95

VELCRO TAPE

This tape has so many uses. Perfect for keeping grilles on speaker cabinets, or use it to keep surfaces together that need to frequently come apart and be reattached. Great for kits to keep battery holders in place.

H10504 100mm x 20mm.....$1.45

HUGE SAVINGS ON SOUND BLASTER CARDS

SOUND BLASTER DELUXE II

The Sound Blaster Deluxe is the ultimate sound board that easily plugs into any slot in your IBM, PC, XT, AT, 386 etc.

- Text to Speech synthesizer
- 11 Vice FM music synthesizer
- Digitized Voice output with 4 KHz to 44, 1KHz Sampling rate.
- Digitized voice input (8 Bit Analogue to Digital conversion)
- Built-in Midi Interface for connecting Musical instruments
- Built-in joystick port
- Built-in stereo Power amplifier
- Bundled software includes: Sbtalker for reading ASCII files & Dr Sbaitso
- Voxkit Voice development toolkit for recording
- Sounds talking, Parrot mimics your speech
- FM Intelligent organ creates orchestra like music using your PC keyboard as input.
- Jukebox - A Windows three application
- Creative wave studio
- Creative talk Scheduler
- Creative Mosaic.

3.5" Version Now ..... **Only $99.00**

SOUND BLASTER PRO DELUXE.....$199.00
SOUND BLASTER 16 BIT ASP.....$449.00
MIDI BLASTER.....$385.00
WAVE BLASTER.....$399.00
VIDEO BLASTER.....$649.00
SPEAKERS TO SUIT JUST $10.00 A PAIR

TRANSISTOR SOCKETS

PCB Mounting low profile sockets with contacts on a 0.1" pitch. Glass filled nylon body with gold-plated phosphor bronze contacts.
Current: 1A per contact. Types are available for 3-lead TO18 transistors and 3-lead TO5 transistors.
Overall height 9.1mm. Pin lenght 3.5mm.
Body dia: TO18 types 7.1mm
TO5 type 10.9mm.

TO18	**P10540**	**$1.95**
TO5	**P10542**	**$2.35**

NEW PRINTER CARTRIDGES

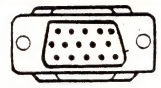
SAMSUNG TONER CARTRIDGE
SAMSUNG 1082P TONER 8 CARTRIDGE
C93296.....$95.95

HP INKJET CARTRIDGES
HP DESKJET 500 STANDARD INK CARTRIDGE **C94010.....$45.95**
HP DESKJET 500 HICAP INK CARTRIDGE **C94020.....$65.95**

SECURITY

PRESSURE MATS

Designed for use with intruder alarms etc. Place the pressure mat under a rug or carpet
S15015 555 x 395 x 3mm....**$22.95**
Designed for use on stairs
S15016 555 x 215 x 3mm....**$19.95**



HIGH DENSITY PLUGS AND SOCKETS

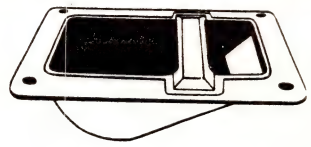
DB15P	1 - 9	10 +	100+
P10886	**$3.20**	**$2.95**	**$2.50**
DB15S	1 - 9	10 +	100+
P10887	**$3.20**	**$2.95**	**$2.50**

HANDLES

SPEAKER HANDLES

Strong and sturdy strap handles for speaker boxes. Has metal sections on each end to ensure a secure and good hold. Total length 240 x 25mm.

H11864	**240 x 25mm**	**$4.95 ea**
H11866	**250 x 28mm**	**$6.95 ea**



CABINET HANDLE

This is the answer to carrying those awkward large speakers or boxes. These handles are very easyto fix to speakers by drilling holes and simply screwing the in. Dimensions 165(W) x 210(L)mm Cutout size 122 x 164mm

H11870.....$19.95 a pair

POCKET HANDLE

For chipboard speaker cabinates or metal enclosures. Panel cutout 100mm x 57mm

H11868.....$4.95 a pair

ROD IRVING ELECTRONICS PTY. LTD.

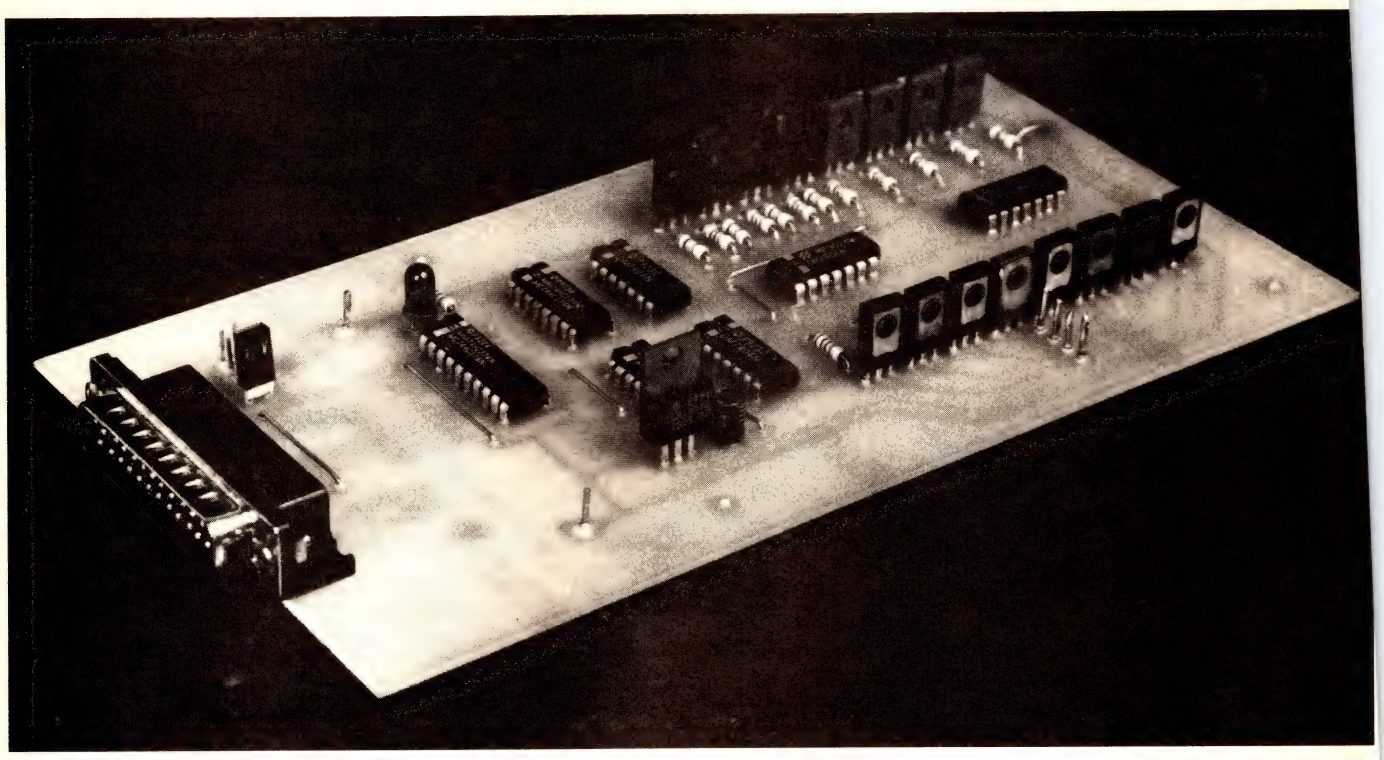
- **HEAD OFFICE**: 56 RENVER RD CLAYTON. PH: (03) 543 7877. FAX: (03) 543 2648.
- **CITY**: 48 A'BECKETT ST, MELBOURNE. PH: (03) 663 6151 / (03) 639 1640. FAX: (03) 639 1641.
- **OAKLEIGH**: 240C HUNTINGDALE RD, OAKLEIGH. PH: (03) 562 8939 FAX: (03) 562 8940
- **NORTHCOTE**: 425 HIGH ST, NORTHCOTE. PH: (03) 489 8866. FAX: (03) 489 8131.
- **BOX HILL**: 1031 MAROONDAH HWY, BOX HILL. PH: (03) 899 6033 FAX: (03) 899 0156.
- **SYDNEY**: 74 PARRAMATTA RD, STANMORE. PH: (02) 519 3888. FAX: (02) 516 5024.
- **ADELAIDE**: 241-243 WRIGHT ST. ADELAIDE. PH: (08) 211 7200 FAX: (08) 211 7273.

BOX HILL STORE NOW OPEN

1031 MAROONDAH HWY BOX HILL
OPPOSITE BOX HILL TOWN HALL

FREE PACK AND POST FOR ORDERS OVER $25.00. OFFER EXPIRES 31/1/94

ECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING ELECTRONICS ROD IRVING



Control stepper motors with your PC

Ever wondered how stepper motors work & how you might control them using your PC? This article gives you the answers & presents a design for a stepper motor controller.

By MARQUE CROZMAN

Having a computer is one thing but haven't you always wanted it to do something in the real world? Robots and computer controlled mechanical devices have always created intrigue for young and old alike but the problem has always remained: how can you easily control mechanical devices with your computer.

A partial answer is sitting inside your very own PC at home. In each floppy and older hard disc drives sits a little stepper motor that accurately positions the heads over the surface of the disc.

When hard discs and floppies die it usually is not the fault of the stepper. Normally it is either a case of the heads taking a nose dive into the disc or the spindle motor reaching the end of its life-span.

This opens a rich supply of small stepper motors just waiting to be put to use in robots and toys, as well as more serious endeavours such as controlling antennas, plotters, servo systems and NC machines; your imagination is the only limit.

Steppers are not like normal motors. When you apply power to them, they will only move through a small arc and stop, as opposed to a regular motor that just keeps turning. They are thus highly suited to numerical positioning, where computers store positions as discrete numbers.

Stepper motors can be used in an open loop system; ie, you can operate them without feedback. All other methods of accurate positioning require feedback to let the system know what the current position of the motor is and to correct it if there is an error. One common method used with steppers is to rotate the stepper until whatever is being moved reaches a limit switch. The controller then has a reference point to work against and therefore it knows where the stepper is.

If you listen to a floppy drive power up, you will hear it find its reference point. The drive controller will then know how many steps to move the head to read a given track.

With a more conventional motor, the magnetic attraction between the motor's stator and rotor causes the

tor to turn in an attempt to make the oles align. By continually moving or dvancing the field, by AC or brushes nd split commutator, the rotor keeps urning.

A stepper motor, on the other hand, ets the rotor's magnetic field line up with the stator, as a compass does when you bring a magnet near to it. We can further this analogy by imagining a large number of magnets around the circumference of a compass. By switching their magnetic attraction on and off, we could have the needle of the compass rotate, by energising each magnet in turn. Thus, we could stop the needle of the compass at any point by stopping the switching sequence.

The magnets in the stator of a stepper motor consist of a ring with iron teeth. Each tooth has a coil wound on it, so that it becomes an electromagnet when it is energised. A coil on the opposite side of the stator is energised in opposition to create the other pole – see Fig.1(a). Increasing the number of teeth on the ring increases the resolution of the stepper; ie, the number of steps per revolution.

We can also double the resolution if we switch on two adjacent magnets, making the rotor come to rest midway between two poles. This is called half stepping and also has the effect of increasing the available torque – see Fig.1(b).

Steppers generally have quite a high number of poles or steps per revolution, with 100 to 400 being common. This is not to say that there are that many electromagnets in the stator. By placing teeth in the rotor as well, the number of poles will be effectively multiplied by the number of teeth in the rotor. So if there are 3 stator poles and 8 teeth in the rotor, the stepper will have 24 steps per revolution or a 15 degree step angle.

Using a digital controller to energise the stator coils gives the sort of control you could expect from a normal DC servo but without feedback. All that has to be done is to calculate how many turns (or degrees) you want, then send that many steps to the motor. The rate at which you send the steps controls the speed or angular velocity of the shaft.

Types of stepper motor

Stepper motors can be divided into three basic classes: variable reluctance, permanent magnet and hybrid.

An assortment of stepper motors. The top middle motor is a variable reluctance type with a rotary encoder on the rear of the shaft, while at bottom left is a rare earth disc stepper. The rest are hybrid types. The motor at bottom right is typical of the steppers found in floppy & hard disc drives.

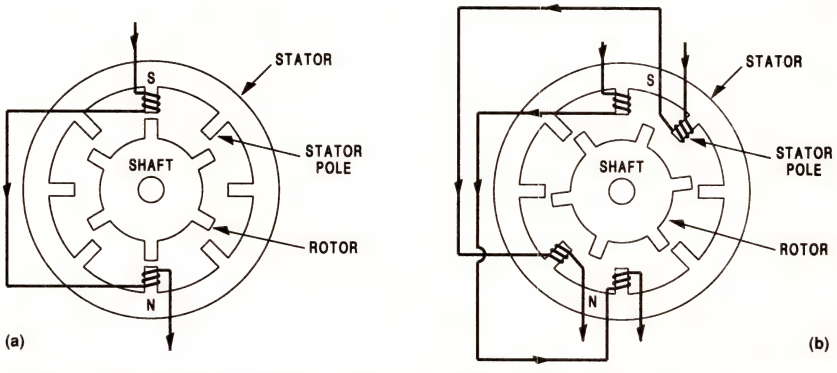


Fig.1(a) at left shows a hybrid stepper motor with one stator pole energised. The nearest rotor pole moves to align itself with the energised pole (the other stator coils have been omitted for clarity). Fig.1(b) shows a hybrid stepper with two stator coils energised. In this case, the nearest rotor pole moves to align itself between the energised poles.

Variable reluctance motors have a soft iron multi-tooth rotor. You can recognise this type by rotating the shaft with your fingers. As the rotor has no magnetism, it rotates freely without poling, whereas permanent magnet and hybrid types have magnetic rotors and pole or "cog" when turned. Variable reluctance steppers are renowned for their high stepping rates and accuracy.

Permanent magnet steppers have a toothless rotor which is radially magnetised, with alternating poles. The stator has two halves, each of which contains a coil. The rotor's poles are attracted to the stator coils when energised. The rotor remains attracted to the closest stator pole even when no power is applied, giving a "detent" torque. These steppers are economically competitive but suffer in terms of accuracy and speed in comparison to other types.

Hybrids are the most popular style of stepper and are the most common in computer equipment. The hybrid combines the stator of the variable reluctance type and the rotor of the permanent magnet stepper to produce a motor with high detent, holding and dynamic torque while retaining high stepping rates.

The newest type of stepper motor is a variation on the permanent magnet type – the rare earth permanent magnet stepper – see Fig.2. These are also known as disc magnet steppers. The rotor is a thin disc which is axially magnetised. This results in a motor

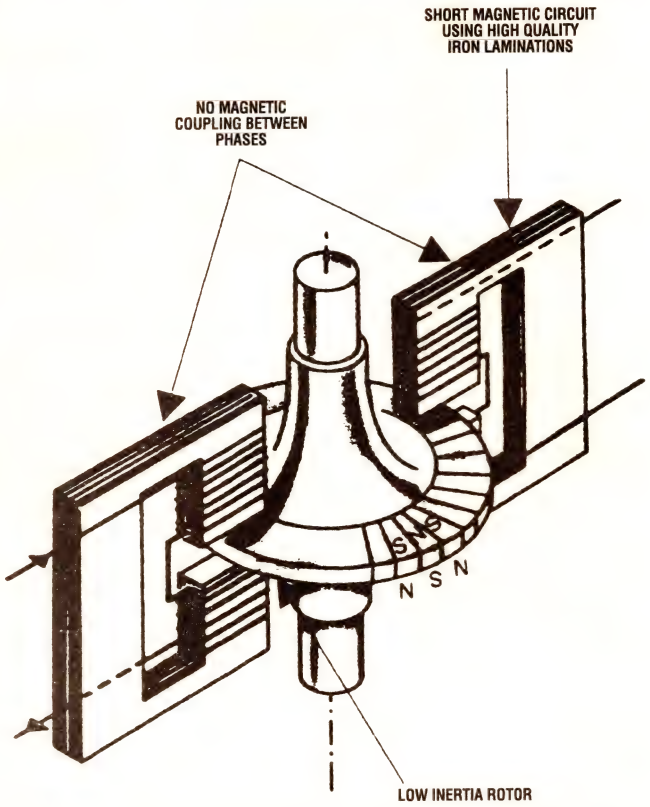


Fig.2: layout of a permanent magnet stepper motor. This particular layout is for one of the new rare earth magnet disc steppers. Note that the magnets are axially aligned with the rotor.

Table 1: Wave Stepping

Step	Phase 1	Phase 2	Phase 3	Phase
1	ON	-	-	-
2	-	ON	-	-
3	-	-	ON	-
4	-	-	-	ON

Table 2: Two Phase Stepping

Step	Phase 1	Phase 2	Phase 3	Phase 4
1	ON	ON	-	-
2	-	ON	ON	-
3	-	-	ON	ON
4	ON	-	-	ON

Table 3: Half Phase Stepping

Step	Phase 1	Phase 2	Phase 3	Phase 4
1	ON	-	-	-
2	ON	ON	-	-
3	-	ON	-	-
4	-	ON	ON	-
5	-	-	ON	-
6	-	-	ON	ON
7	-	-	-	ON
8	ON	-	-	ON

with a very low moment of inertia, high acceleration and good dynamic behaviour.

Disc magnet steppers outperform all other types. They are the most efficient and have by far the highest holding torque and power output per kilogram of motor, superior accuracy and high start/stop frequencies – see Fig.5.

Identifying the sex of motors

There are two methods of winding stepper motors – unipolar and bipolar, as shown in Fig.3. Bipolar steppers have one winding on each stator pole (monofilar wound). The magnetic polarity of the stator pole is changed by reversing the current in the coil. Reversing the current through the coil requires a circuit capable of switching polarity.

Unipolar steppers have two coils per stator pole, one for each direction (bifilar wound). Changing the direction of movement involves switching the current from one coil to the other. Commonly, the two coils have a common connection to reduce the number of wires exiting the motor. The power supply can be much simpler than that for the bipolar, as you simply need single switches to turn different coil segments on and off. However, unipolar steppers have a lower torque than bipolars because only half of each winding is energised at a time – see Fig.4.

Identifying steppers is easy. Bipolar steppers have four leads and unipolars have either five or six. Reading the name plate will also give an

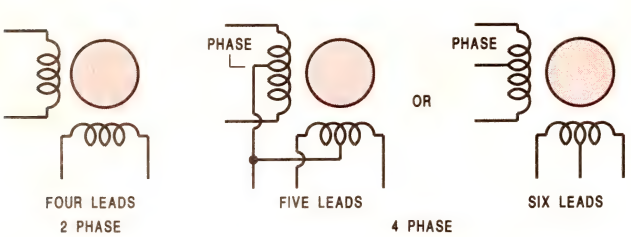


Fig.3: the diagram at left shows a bipolar winding arrangement, while at right are two unipolar winding arrangements. In the unipolar arrangement, only one half of the coil on each stator is energised at any given instant.

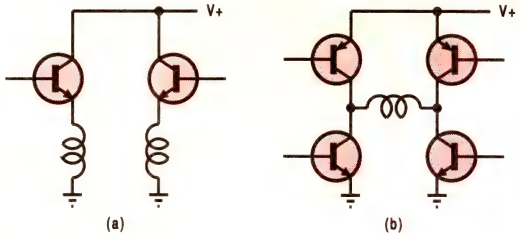
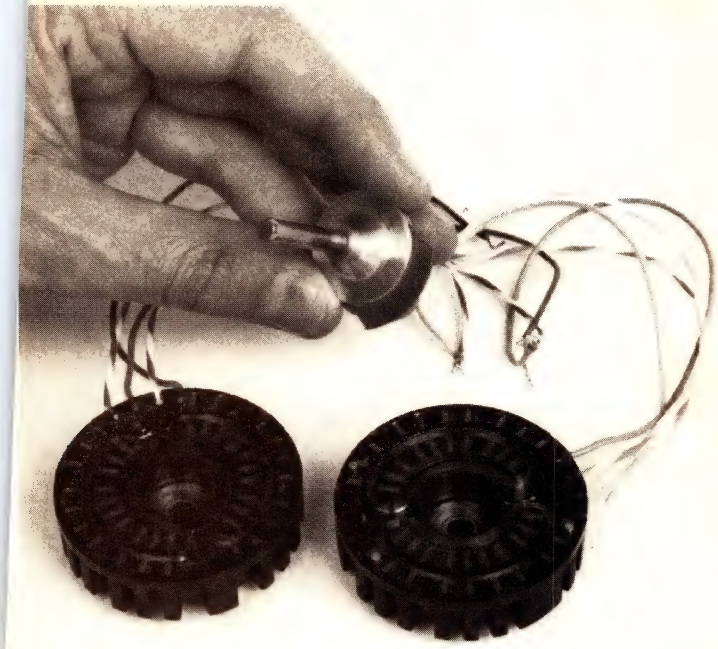


Fig.4(a) at left shows a unipolar switch, while Fig.4(b) shows a bipolar (or H-bridge) switch. The unipolar drive arrangement only needs one switch per coil whereas the bipolar drive requires four switches per coil.



The photo above shows the pole arrangement of a rare earth permanent magnet stepper motor. Its rotor is damaged but the axial rare earth magnet segments in the remaining thin disc section can still be clearly seen. At right is the view inside a hybrid stepper motor. Note that both the magnetic rotor & the stator have teeth. The stator coils can also easily be seen in this photo.

idea as to what type it is.

To make the motor step, power is applied to each coil in turn. Steppers have three different stepping formats: wave, two-phase and half-step sequences. Each has its own advantages and disadvantages. Wave drive energises one coil at a time and the sequence is 1, 2, 3, 4, 1 or 1, 4, 3, 2, 1, depending on direction. Wave drive is the most economical as the power supply has only to provide enough current to drive one coil at a time, making it less expensive – see Table 1.

Two-phase drive is similar to wave drive as far as step length is concerned but consists of energising two adjacent coils at the same time. The coils are energised in the order 12, 23, 34, 41, 12 or 14, 43, 32, 21, 14, depending on the direction. This increases the amount of torque produced over the wave-drive, as the rotor moves from the tug of two energised windings to the tug of the next two energised windings. The disadvantage is that the power supply requirements are increased – see Table 2.

Half-stepping alternates between wave and two-phase stepping to double the number of steps per sequence. It has the sequence of 1, 12, 2, 23, 3, 34, 4, 41, 1 or in the opposite direction, 1, 14, 4, 43, 3, 32, 2, 21, 1. The torque produced increases because the step length is reduced and each alternating step has two windings energised. The positional accuracy is also increased but it means that two steps have to be sent for every previous single full step. The power supply will also need to be of the same capacity as the two-phase drive – see Table 3.

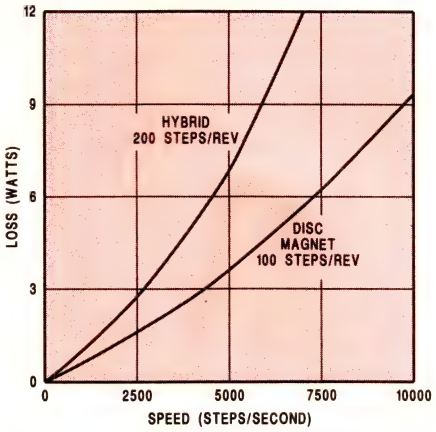


Fig.5: comparison of losses between hybrid & rare earth permanent magnet disc stepper motors operating at the same torque.

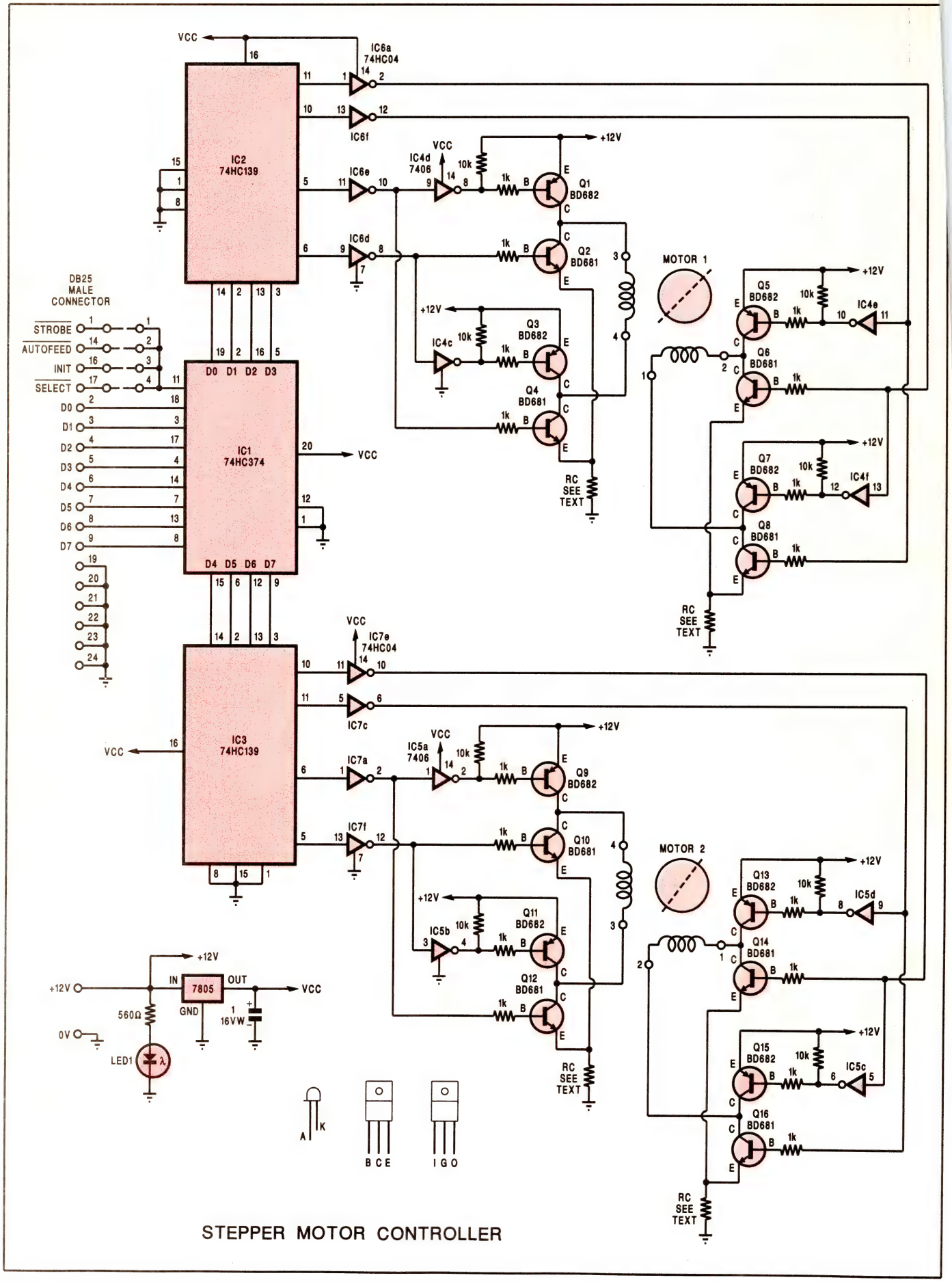
The cheapest source of stepper motors is discarded floppy and older hard disc drives. Computer repair companies usually have a whole hoard of goodies from dead machines and will part with them for a token price. Ram Computers at Manly, NSW is one place that has a whole stock of steppers from printers, floppies, hard discs and other various bits of dead equipment.

Stepper controller board

This has been designed to be as flexible as possible and can be run from any parallel printer port. It will drive two steppers, either unipolar or bipolar types, or both.

In the IBM PC compatible, the printer port is normally latched, in that once the data has been written to the port, it remains there until more data is written to it. This is not the case with some other computers though.

Using a latch on the card fixes the problem with unlatched printer ports but there is another advantage. It allows us to implement selectable addressing. One parallel port can then drive up to four cards, each with its own address, giving control of up to eight motors simultaneously.



STEPPER MOTOR CONTROLLER

;.6 (left): data from the printer ard is latched into IC1 & decoded IC2 & IC3 which each drive two bridges. Each pair of H-bridges then ives one stepper motor. Note that unipolar stepper motors, the bridges are not required & therefore 4, IC5 & the PNP transistors can be nitted (see text).

Having a latch on the card is also seful if you are not using a printer ort but perhaps driving the card from microcontroller such as the South-rn Cross Z80 computer recently de-cribed in this magazine.

In this case, the end section of the oard that has the DB25 connector on can be removed, leaving a header hat accepts 8 data lines and an enable ine. However, we are getting ahead of urselves.

How it works

The circuit of the controller board s shown in Fig.6. Essentially, the printer is connected to IC1, a 74HC374 octal D latch. This can be considered as eight D-type flipflops with one common latch enable or clock input, pin 11. Data can be loaded into the eight inputs and then when the latch enable pin goes high, that data appears at the eight outputs (pins 19, 2, 16 & 5 and pins 15, 6, 12 & 9).

To send a byte of data to the controller, the computer writes a byte of data to the printer port and then toggles pin 11 high. This data then appears on the outputs of the latch, as noted above. The output lines drive a pair of 74HC139s, which are dual two to four line decoders.

Pins 5 and 6 of IC2 are the used outputs for the first decoder (two outputs are unused) and pins 10 and 11 are the used outputs for the second decoder. IC6 inverts the decoder outputs from active low to active high for the driver circuit.

The driver circuit is an H-bridge comprising transistors Q1, Q2, Q3 and Q4. Q1 and Q2 are complementary switches so that when Q1 is on, Q2 is off and similarly when Q3 is on, Q4 is off. All four switches can be operated in such as way that the supply voltage is applied to the motor coil with one polarity or the other, or all four switches may be off so that no power is applied to the coil. The state of the switches is controlled by decoder IC2 which only responds to valid data at its inputs.

Note that IC6 only controls the NPN transistors in the H-bridge. The PNP transistors are driven by IC4, a 7406 hex inverter with open collector outputs. IC4 is there for two purposes. First, it provides level translation from the 5V (TTL) outputs of IC6 to the 12V bridge circuit and second, it inverts the signals again to give the correct sense for the PNP transistors.

IC2 controls two H-bridges, the second comprising Q5-Q8, and this acts in the same way, to control one motor (with two coils). IC3, its associated buffers (IC5 and IC7) and the H-bridge drive the second stepper motor.

Note that pin 11 of IC1 is shown as connected to one of four lines from

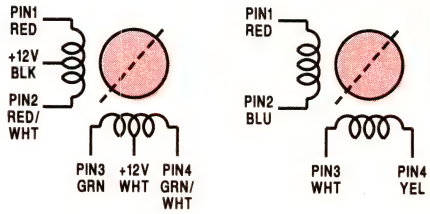


Fig.7: refer to this diagram for the lead colours & pin connections when connecting the stepper motor to the controller board. Note that the centre taps for a unipolar stepper are tied directly to the +12V supply rail. Warning – some steppers use a different colour coding & you may need a multimeter to sort out the windings.

the printer port, viz, Strobe, Autofeed, INITialise or Select. These are by way of links on the PC board and are selected when you build it. In this way, it is possible to build four separate controller boards and have them all running from the printer port simultaneously. The software does the selection for each controller; ie, the relevant line is toggled for the data sent to each controller.

The four least significant bits (D0-D3) are used to control motor 1 while the four most significant bits (D4-D7) control motor 2.

Unipolar motors

The circuit description above refers to bipolar stepper motors. If you propose to use unipolar motors, the H-bridges are not required. Instead, the buffered outputs from IC6 and IC7 directly drive the NPN Darlington tran-

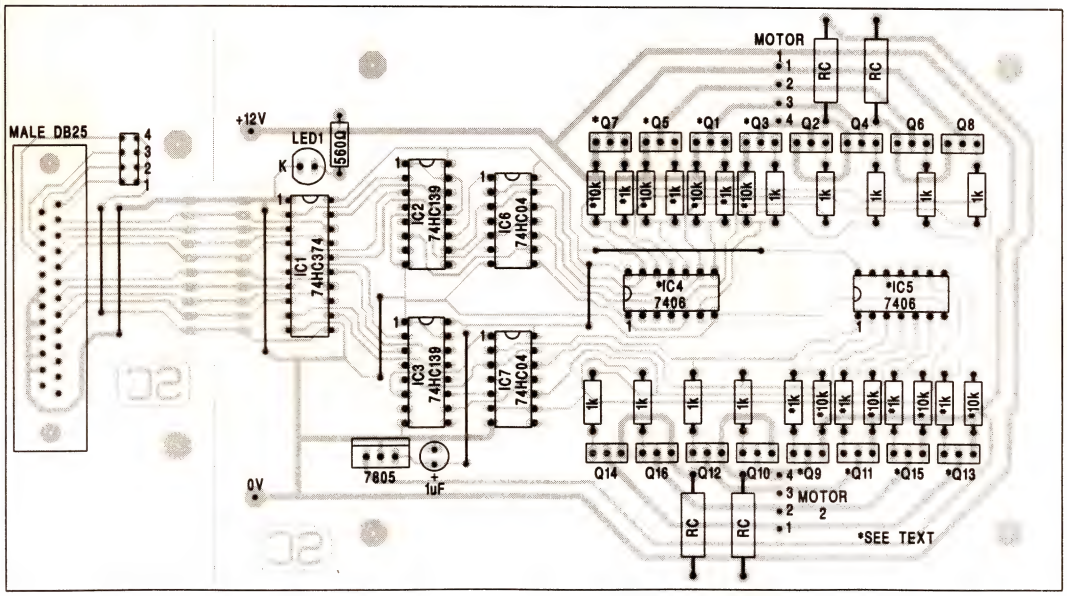


Fig.8: install the parts on the PC board as shown here & note that those transistors & ICs marked with an asterisk can be omitted if the board is to control a unipolar stepper motor. Refer to the text for the linking options at top left.

Table 4: Resistor Selection

5V stepper current rating	Current limiting resistor
500mA	15R
800mA	8R2
1A	6R8
1.5A	4R7

Table 5: Motor Codes

Phase energised	Motor 1 (HEX)	Motor 2 (HEX)
1	01	10
2	02	20
3	04	40
4	08	80

Table 6: Debug

To load a byte into the controller	
o 378 (mcode)	load motor code into port A
o 37A 05	assert card1's latch enable low
o 37A 04	pull the latch enable high to load the data into the latch
q	quit from using debug

Table 7: Motor Outputs

Phase	Motor 1	Motor 2	Output	
1	D0	D4	1 +	2 -
2	D1	D5	3 +	4 -
3	D2	D6	1 -	2 +
4	D3	D7	3 -	4 +

Table 8: Card Selection

Card Selected	Printer Signal	Port C Value (HEX)
No card selected	-	04
Card 1	-STROBE	05
Card 2	-AUTOFEED	06
Card 3	+INIT	00
Card 4	-SELECT	0C

sistors; ie, Q2, Q4, Q6 and Q8 for IC6 and Q10, Q12, Q14 and Q16 for IC7. IC4, the PNP transistors and their resistors can be omitted.

Similarly, for the second motor, IC5, the PNP transistors and their resistors can be omitted. Note that the centre taps of the motor winding are then connected to +12V – see Fig.7.

Putting it together

The stepper motor controller board measures 187 x 103mm and is coded 07201941. It has a DB-25 male socket at one end and two lines of plastic transistors at the other – see Fig.6.

Start assembly by checking the board against the printed artwork for flaws such as bridges between tracks or broken tracks. These should be repaired with a utility knife or soldering iron if needed. Assuming all is well, construction can commence with the PC pins and wire links. If the board is being built for 12V steppers, install wire links in place of the current limiting resistors R1-R4.

5V steppers will require the current limiting resistors, as specified in Table 4.

The resistors and the 1µF electrolytic capacitor can go in next, followed by the 4-way, 2-pin header for address selection. This done, install the 5V regulator and LED, making sure they're in the right way.

If you desire, IC sockets can be used for all the integrated circuits. Otherwise, directly solder in all the ICs, taking care while handling them, as most are CMOS devices.

As noted above, if the board is being constructed to cater for unipolar motors only, ICs 4 and 5 may be left out, as can all the PNP Darlingtons and associated resistors. All these components are marked with an asterisk on the component overlay diagram of Fig.8.

Lastly, install the male DB25 plug. Be careful not to bridge any pins together whilst soldering it in, as it can be quite fiddly. Bridging could lead to some fairly weird problems later on.

Testing

Apply 12V to the board and check that +5V is present at pin 14 of ICs 4, 5, 6 and 7, at pin 16 of IC2 and IC3, and at pin 20 of IC1. If any of the Darlington transistors gets hot, you have a problem. If so, power down and recheck the placement and orientation of all components.

When all is OK, connect the board to the printer port, then turn on the computer, power up again and run the test program on the stepper software disc which is available from SILICON CHIP – see parts list.

If you don't have this software, using debug, load the motor codes into the base address of the card, then write a 1 to the enable bit followed by a 0. These last two writes load the data into the latch – see Tables 5 and 6.

After each step in the program or after manually writing each set of codes, check the voltage on the outputs of each phase where the motors connect to the board. There should be 12V across each phase that is on – see Table 7.

All things being equal, it's time to connect up a stepper motor and run the stepper software included on the stepper software disc. This contains example programs written in Qbasic and C, as well as the initial testing program. The C programs are more efficient and allow the motors to spin up to full speed. All programs are fully documented and the disc comes with a READ.ME file which provides

PARTS LIST

1 PC board, code 07201941, 187 x 103mm
1 DB25 right-angle male socket
1 4-way 2-pin header
1 header jumper
10 PC pins
1 1µF 50VW PC electrolytic capacitor
8 10kΩ 1% 0.25W resistors
17 1kΩ 1% 0.25W resistors

Semiconductors

1 74HC374 octal D-latch (IC1)
2 74HC139 dual decoder (IC2,3)
2 74HC04 hex inverter (IC6,IC7)
2 7406 hex inverter (IC4,IC5)
8 BD681 NPN Darlington transistors (Q2,Q4,Q6,Q8, Q10,Q12,Q14,Q16)
8 BD682 PNP Darlington transistors (Q1,Q3,Q5,Q7, Q9,Q11,Q13,Q15)
1 7805 5V regulator
1 5mm red LED (LED1)

How to buy the software

The software for driving the stepper controller can be obtained by sending $6 plus $3 for postage and packing to SILICON CHIP, PO Box 139, Collaroy, NSW 2097 or by faxing your credit card authorisation to (02) 979 6503.
Please nominate your choice of 3.5-inch or 5.25-inch floppy disc to suit IBM compatible computers. We accept credit card authorisations for Bankcard, Visacard and Mastercard.

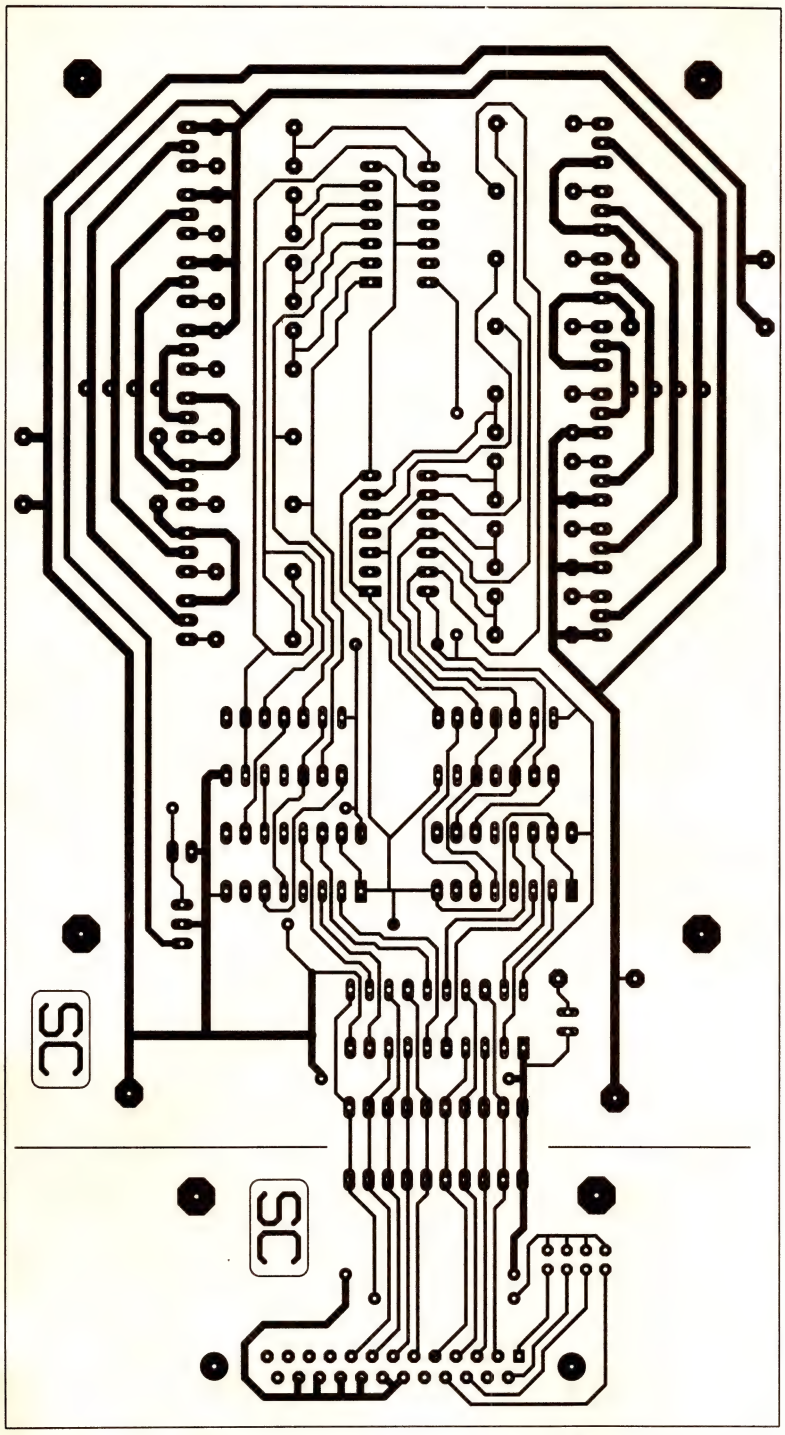


Fig.9: this is the full-size etching pattern for the PC board. The board measures 187 x 103mm & carries the code number 07201941.

other helpful information on stepper motors.

Cascading controller boards

If you want to use two or more controller boards from the printer port, they can be daisy-chained using a 25-way ribbon cable and IDC DB-25F plugs. You then need to set the linking via the DIP header to use one of the four enable lines – see Table 8.

Acknowledgments

Our thanks to RAM Computers at Manly, NSW for the supply of sample steppers from dead floppy disc drives. Thanks also to the University of Technology which supplied information on rare earth magnet stepper motors.

KALEX
The UV People

ETCH TANKS
● Bubble Etch ● Circulating

LIGHT BOXES
● Portuvee 4 ● Portuvee 6
● Dual Level

TRIMMER
● Ideal

PCB DRILL
● Toyo HiSpeed

MATERIALS
● PC Board: Riston, Dynachem
● 3M Label/Panel Stock
● Dynamark: Metal, Plastic

✳ AUSTRALIA'S NO.1 STOCKIST ✳

KALEX

VISA

40 Wallis Ave, East Ivanhoe 3079.
Phone (03) 497 3422, Fax (03) 499 2381

AUDIOPHILES!

Now high audiophile quality components & kits are available in Australia. Buy direct & save.

*Kimber, Wonder, Solen & MIT Capacitors
*Alps Pots *Holco resistors *High Volt. Cap.
*Gold Terminals & RCA *WBT Connectors
*Kimber Cables * Interconnect Cables
*Output Transformers (standard or customised)
*Power Transformers *Semiconductors
*Audio Valves & Sockets *Wonder Solder
*Welborne Labs Accessories

Valve & Solid State Pre-Power Amplifier Kits
*Contan Stereo 80 Valve Power Amp. (As per Elect. Aust. Sept. & Oct. '92)
*Welborne Labs Hybrid Preamp. & Solid State Power Amplifier

Send $1.00 for Product Catalog
PHONE & FAX: (03) 807 1263
CONTAN AUDIO
37 WADHAM PARADE
MT. WAVERLEY, VICTORIA 3149.

Kenwood's DCS-9120 100MHz digital oscilloscope

Kenwood's DCS-9120 programmable digital storage oscilloscope provides both analog & digital modes of operation, with 4-channel 100MHz operation in the analog mode & two channels at up to 40 megasamples/second in storage mode.

First impressions of the DCS-9120 are that it is a fairly compact unit with a front panel that has lots of knobs, buttons and control labelling. The knobs for vertical sensitivity and timebase do not have calibrations as their settings are displayed on the CRT screen, as is the triggering level and even the date and time if required.

Most of the pushbuttons on the front panel are accompanied by backlit legends to indicate the selected setting. These are good because they give an unambiguous indication of the various settings.

On the rear panel are ports for a pen recorder, plotter and an RS-232 serial interface. The DCS-9120 can also be controlled via a GP-IB interface so that it can be used for automated testing in production or other applications.

Physical dimensions of the oscilloscope are 310 x 160 x 510mm, not including the tilting handle. Its mass is 10kg.

When used in analog mode, the DCS-9120 functions as you would expect for a 4-channel 100MHz oscilloscope. Each of the four input channels has its own sensitivity adjustment from 5V/div down to 1mV/div and an uncalibrated variable knob can be used to vary the sensitivity within these ranges. In addition, the 100MHz bandwidth of the oscilloscope can be reduced to 20MHz to reduce noise on the display when signals below 20MHz are being measured.

Signal coupling of the inputs can be DC, AC or grounded, while both the channel 2 and channel 4 inputs can be inverted as well. This feature can be used to provide a differential input mode by ADDing channel 1 to channel 2 or channel 3 to 4.

Each input socket incorporates a detector which automatically adjusts the sensitivity (Volts/Div) reading on the screen whenever the supplied PC-31 probes are switched to 10:1. If other brands of probes are used, you will have to resort to mental arithmetic to multiply the sensitivity by 10 when 10:1 is selected on the probe.

Sweep time is selectable from 20ns/div to 0.5s/div in 23 ranges, with fine adjustment and x10 sweep magnification available. Timebase modes are A, B or delayed trace, A intensified by B, A and B alternating or X-Y mode. The delay between the A and B timebases can be either a continuous delay, a trigger delay or a count delay.

Triggering modes

Triggering modes are Auto, Norm, Single and Fixed, with the usual CH1-CH4 source selection or line frequency triggering. You can also select Vert triggering which automatically triggers on the lowest selected channel number. No external triggering input is provided. Coupling for the trigger signal can be DC, AC, High Frequency Rejection or TV (line or frame 1 or frame 2, NTSC or PAL).

Horizontal or vertical cursors can be displayed on-screen to enable voltage, period and frequency measurements, a fairly standard feature of scopes with CRT readouts.

Menus

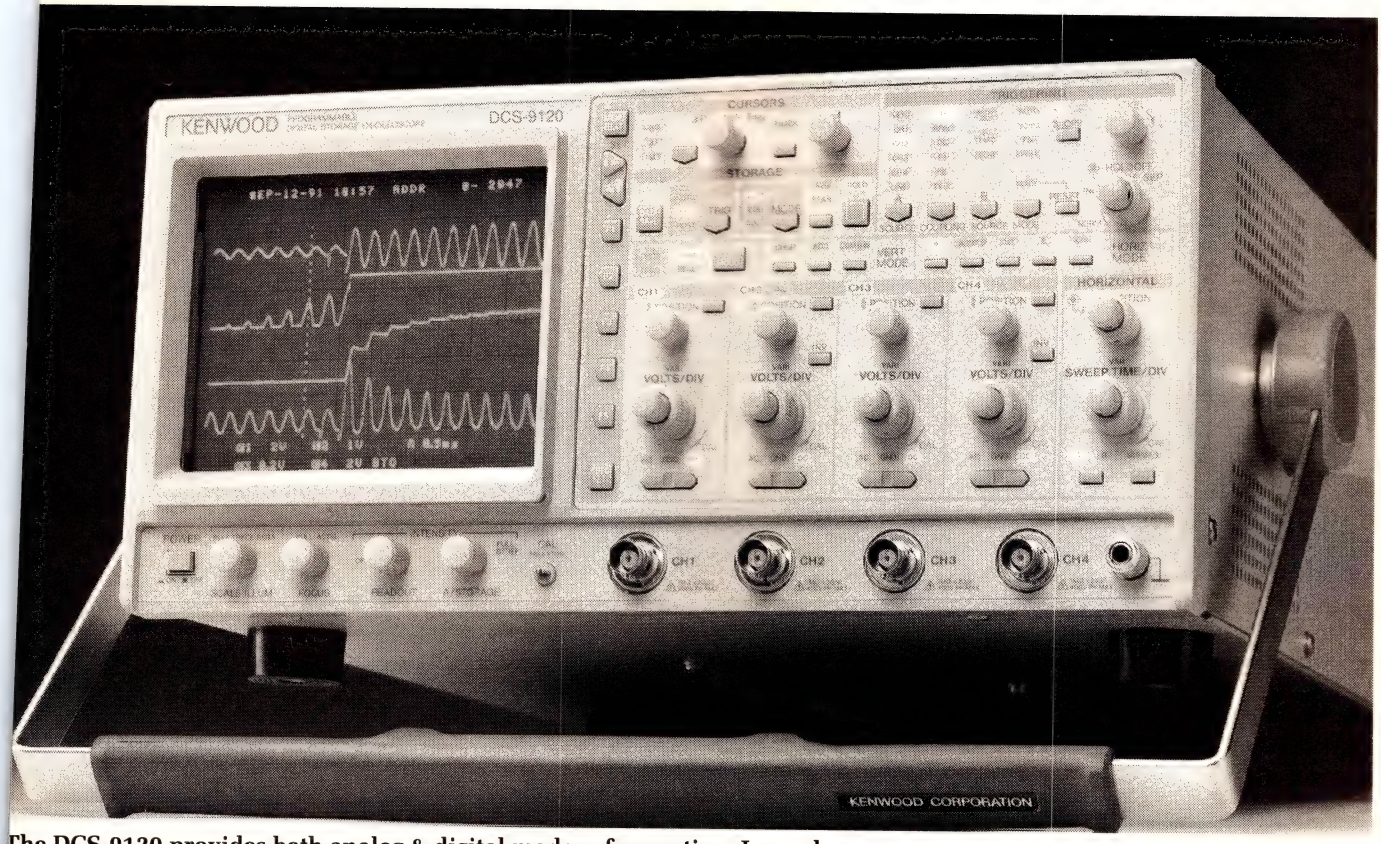
Apart from the front panel controls there are many functions and operations that can be accessed via the menu options. The five menu subsets are Processing, Memory, Set, Output and Option. Some functions selected via the menus are only available with the storage facility. For example, if you select the average display from the processing menu, it will not operate in the analog mode. The averaging feature is very useful for improving the signal to noise ratio of the displayed signal since it filters out random noise. Averaging can be selected from between 2 and 256 waveforms.

Other functions available from the processing menu are interpolation (off, linear, sine and spline), calculation (+, -, x, /) between channels, and peak detection of maximum, minimum or both.

Memory menu options allow you to select the display address, memory size and reference memory. The latter is a memory space into which a waveform can be stored, to be recalled at a later date and compared with another waveform on the screen.

In the Set menu, you can change the delayed triggering options to be displayed in divisions or real time (seconds). You can also set the type of TV triggering, buzzer modes, display offset and time display modes and settings.

The Option menu provides programming features so that on-panel settings can be stored, comments can be made on-screen and the present status displayed. A parameter sub menu provides selection of automatic calculations which can be done by



The DCS-9120 provides both analog & digital modes of operation. In analog mode, its bandwidth is 100MHz, while in digital mode it can operate at 40 megasamples/second. Many of the functions are accessed via menu options.

the oscilloscope and then displayed on the screen. You can only select one per trace but each trace can have a different parameter displayed. The parameters selectable are period, frequency, pulse width, rise time, fall time, delay, overshoot, undershoot, peak to peak, RMS volts, top level, base level, amplitude and power.

Digital storage

Switching from analog to digital modes is as simple as pressing the Mode switch. The difference in the storage mode is clear, however, if you need to manipulate the display. You can magnify the stored waveform by up to 100 times or compress it to $^1/_{10}$th of the original, depending on how you want to observe the signal. You can also perform arithmetic operations between traces and set up peak hold for catching glitches as little as 50ns wide.

Strangely enough, you can also observe the waveform before the triggering point. This is a feature only available on storage oscilloscopes and is possible since the storage of the waveform is continuous and the triggering point really only tells the scope what part of the waveform you want to observe. Consequently, you can observe the waveform before or after the triggering point, depending on whether post or pretriggering is selected.

The other interesting feature is the way the storage memory can be set up. There are two separate 16K word waveform memories for channel 1 and channel 2. One is called the acquisition memory and the other the reference memory. Each word is eight bits wide. You can set up the memory to be 2K words long for eight screens of storage, or 16K words long for storing a large continuous waveform section.

Storing waveforms

As is the case with most storage oscilloscopes, it takes some time to become familiar with the operating features. A lot of the difficulty was due to the extraordinary number of options that are available in the storage mode. However, we found that digital storage was particularly useful for catching glitches and for observing non-repetitive waveforms such as the firing of a fluorescent tube – virtually impossible to observe on a normal analog scope.

We had a minor complaint when using the Delta REF/DLY TIME rotary control to scan through the eight x 2K memory blocks. In operation, the delta V cursor switch was often accidentally bumped due to its close proximity to this control.

The instruction manual for the oscilloscope is good although there are spelling mistakes and strange English in some parts. However, all the features of the oscilloscope are well explained and examples are given for both analog and digital storage modes.

Overall, we liked the features of the DCS-9120. It provides the best of both types of scope; the fine detail waveforms in the analog mode and the facility to store and manipulate waveforms in the digital storage mode. The ability to print out waveforms and control the unit via the GP-IB interface also help make this oscilloscope a very versatile unit. It should appeal to a wide variety of users for laboratory, test bench and production use.

The Kenwood DCS-9120 is priced at $9308 plus 20% sales tax if applicable and it comes with a 12-month warranty. For further information, contact the Australian distributor for Kenwood test equipment, Nilsen Instruments, 18 Hilly St, Mortlake, NSW 2137. Phone (02) 736 2888. (J.C.) **SC**

PRODUCT SHOWCASE

World's smallest HF transceiver

Kenwood Electronics has introduced the world's smallest HF Transceiver, the TS-50s. Designed for operation on the 160 to 10-metre amateur bands plus continuous coverage from 500kHz to 30MHz, the TS-50S also supports SSB (LSB & USB), CW, AM and FM modes of operation.

Measuring 179mm wide, 60mm high and 233mm deep and weighing 2.9kg, the TS-50S is designed for the ham shack or office and for mobile installations. Although small in size, the TS-50S delivers 100 watts in SSB, CW, FSK and FM modes and incorporates an automatic cooling fan.

With 100 channels for transmit and receive frequencies, the TS-50S can hold both the A and B VFO frequencies enabling FM split-frequency repeater operation. The split feature allows the user to transmit on one VFO and receive on another. Similarly, in TF-SET mode, the operator can 'lock' the receiver frequency and then find the best frequency at which the DX station is located.

Optional extras include an AT-50 automatic antenna tuner, AT-300 automatic antenna tuner for long wi and whip antennas, MB-13 mobi mount, PS-32 power supply, LF-30 low pass filter, TL-922 linear ampl fier and SP-50B mobile speaker.

Kenwood's TS-50S is covered by twelve month parts and labour wa ranty and it has a recommended reta price of $1589. For further informa tion on the TS-50S or other Kenwoo products, contact Kenwood on (02 746 1888.

Low priced colour scanner

Hewlett-Packard has introduced the lowest priced, highest-performance colour and greyscale flatbed scanner it has ever produced, the HP ScanJet IIcx. With improved software and enhanced resolution, the new unit performs up to twice as fast as the previous model.

The HP ScanJet IIcx has 1600 dpi enhanced resolution and 400 dpi optical resolution for both image and text scanning. Gray scale scanning takes eight seconds, compared with 15 seconds for the previous model.

An optional transparency adapter allows the scanner to work with a variety of hardcopy media, such as 35mm slides, transparencies and paper. The adapter accepts transparencies ranging in size from 35mm to 8.5 x 11.7 inches. The scanner also accepts standard paper sizes up to 11 x 14 inches. An optional automatic document feeder provides unattended scanning for up to 50 pages.

Recommended retail price of the ScanJet IIcx is $2258 including sales tax and it is available from authorised HP dealers. The optional 50-page automatic document feeder is $1168.

For further information on the ScanJet IIcx and other HP products and sevices, phone 13 1347 (no STD area-code required).

Rugged clamp meter from Fluke

Fluke Corporation has developed a new clamp meter which can measure AC current to 400A and AC volts to 600V. The new unit is intended for commercial, industrial and residential electricians as well as for HVAC/R (Heating Ventilation Air Conditioning Refrigeration) service technicians. Its tapered jaws, with centred opening, give easy access to conductors in crowded junction boxes.

The Model 30 is more accurate and easier to use than analog meters. A HOLD button "freezes" the display so values can conveniently be read. It conforms to the safety standards of the IEC 1010 and has UL, CSA and TUV certifications. Accuracy is quoted as ±1.3%, specified for one year after calibration. The operating temperature range is from -10°C to +50°C.

For further information, contact Philips Test and Measurement, 34 Waterloo Rd, North Ryde, NSW 2113. Phone (02) 888 8222.

Compact DC-DC converters

Claimed to be the world's most advanced, high density single and triple output DC-DC converters, the Micro-Verter uV series can deliver up to 250 watts.

These miniature converters are available in three input voltage versions: 28 & 48V DC for the telecommunications industry and 300V DC for distributed power applications.

Operating at a constant frequency, the Micro-Verter series can be paralleled for current sharing and are fault tolerant with a true n+1 redundancy, offering MTBF of over 1.1 million hours. The converters have non-shutdown over-voltage protection, thermal and input OVP protection, extremely low thermal resistance and an excellent transient response.

As well as the single or triple voltage outputs, an "output good" signal is provided and there is an optional "sync" pin.

For further information, contact Amtex Electronics, 13 Avon Road, North Ryde, NSW 2113. Phone (02) 805 0844.

Central Coast annual field day

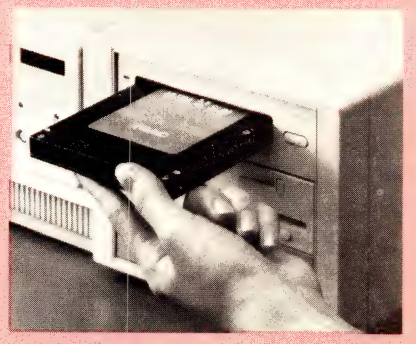
The Central Coast Field Day is one of the longest running events in the Australian amateur radio calendar. The next Central Coast field day will be held on Sunday 27th February 1994, at Wyong Racecourse and this will be the 37th year of this popular event.

As usual, the large contingent of suppliers of electronic equipment, components and books will be attending. These companies will have their latest products on display and many traders will have items on sale at very special Central Coast Field Day prices.

Last year, the popular flea market attracted a large number of people who traded an enormous amount of surplus electronic equipment to eager buyers from trestles, trailers or from the boots of their cars.

This year an even bigger program of interesting lectures and equipment displays has been arranged. More than two thousand people attended last year's Central Coast Field Day and the next one at Wyong Racecourse will be bigger and better than ever, so mark the 27th February 1994 down in your calendar. Gates will open at 9am in wet or fine weather and all displays are under cover.

High capacity removable drive



Southend Data Storage have announced a new removable hard disc drive from Teac Corporation. The Drive, called TEAC-STOR consists of the drive, docking bay for a 5.25-inch slot and carrying case, and is available in capacities of 250 and 360 megabytes.

Both the 250Mb and 360Mb models require only a single 5V DC power source, a first for 3.5-inch hard disc drives. Power consumption during read/write operation is only 2.5 watts, giving a significant power saving. Both drives are compatible with the industry standard IDE interface, making them suitable for almost any system.

For further information on the TEAC-STOR or other TEAC data storage product, contact Rick Stanford of Southend Data Storage, PO Box 25, Menai, NSW 2234. Phone (02) 541 1006.

Compact R/C modules

McLean Automation has introduced a series of 'bricks', being a range of portable radio control modules housed in Clipsal 265/5 (210 x 110 x 80mm) enclosures with a carry bar. Similar in appearance to a house brick with a handle, these rugged units are affordable and Australian made.

The brick series extends from simple single button transmitters to multi-code transceivers capable of actuating multiple remote loads with separate on/off coding and receiving 'loop back'

VIDEO & TV

SERVICE PERSONNEL
TV & VIDEO FAULT LIBRARIES

AVAILABLE AS PRINTED MANUALS $90 EACH + $10 DELIVERY
BOTH MANUALS VIDEO & TV $155 + $15 DELIVERY
OR AS A PROGRAM FOR IBM COMPATIBLES $155 + $10 DELIVERY

FOR MORE INFORMATION
CONTACT
TECHNICAL APPLICATIONS FAX / PHONE (07) 378 1064
PO BOX 137 KENMORE 4069

Philips slashes DCC prices

In a dramatic move to get DCC players and recorders moving in the marketplace, Philips has announced big price cuts. The full-house DCC900 recorder, previously priced at $1799, is now $999 while the DCC600, previously $1499, is now $799. And the recently released DC130, pictured here being used by Australian aerobics champion Sue Stanley, is now $699.

Customers who have already purchased a DCC player or recorder at the old prices need only call Philips at (008) 80 3312 to receive a complimentary set of 25 pre-recorded DCCs.

acknowledgement of switching function.

All systems have a 2km range from a radio licence exempt HF transmitter with excellent long wavelength diffraction performance around obstacles in the propagation path. The transmissions are digitally encoded and the dry batteries typically give 6-12 months' service.

For further information, contact McLean Automation, PO Box 70, Freemans Reach, NSW 2756. Phone (045) 796 365.

High-power subwoofer for cars

Kenwood Electronics has announced a subwoofer and dedicated subwoofer amplifier guaranteed to rattle the windows. Called the Letterbox, it measures only 251mm wide, 266mm high and 400mm deep and can be mounted behind the seat, on a van floor or in the boot.

The Letterbox is a bass reflex design employing what Kenwood call a spherical flow duct. This is a tapered

port to enhance low frequency r sponse down to below 40Hz. Combir ed with reasonably high efficienc (90dB), it can deliver lots of bass. Th unit can be used on its own or in multi-subwoofer set up and can han dle bass program material up to 200W

To drive the subwoofer, Kenwoo markets the KAC-714 mono powe amplifier, rated at 100W but capabl of delivering around 200W on peaks Measuring only 280mm wide, 50mm high and 170mm deep, the KAC-714 can fit snugly into most boots.

A built-in crossover offers variable cut-off from below 30Hz to 200Hz and an input gain control matches the sound levels to other speakers.

The Letterbox subwoofer is priced at $399 while the KAC-714 mono power amplifier is $349. Both units are covered by a 12-month parts and labour warranty. For further information on Kenwood car audio products and your nearest Kenwood car audio dealer, phone (008) 066 190.

Digital DC power supplies

The new Leader Digital Series regulated DC power supplies consist of five models: two 18V, two 36V and one 70V model. Intended for R & D, automated and educational applications, the series features optional GPIB for computer control.

The power supplies can also be remotely controlled using the standard remote control connector. For stable output, voltage drops caused by test lead resistance and contact resistance at the output terminals are compensated for by using the sensor plug provided.

For further information, contact AWA Distribution, 112-118 Talavera Rd, North Ryde, NSW 2113. Phone (02) 888 9000. **SC**

Luxman amplifier & CD player: continued from p.32

checked out at -93dB at 1kHz which is not quite as good as the claimed -100dB but the difference is largely academic since anything over -70dB is more than adequate.

Measurements aside, we can state that both the A-371 stereo amplifier and D-351 compact disc player are very fine products. They work well and produce excellent sound quality and, as the final icing on the cake, they come with a 5-year full parts and labour warranty.

Pricing is $1399 for the A-371 amplifier and $799 for the D-351 CD player. Luxman equipment is available from selected hifi retailers. For the name of your nearest dealer, contact the Australian distributor for Luxman, International Dynamics Pty Ltd, 78-80 Herald St, Cheltenham, Vic 3192. Phone (03) 585 0522. (L.D.S.)

ASK SILICON CHIP

Got a technical problem? Can't understand a piece of jargon or some technical principle? Drop us a line and we'll answer your question. Write to: Ask Silicon Chip, PO Box 139, Collaroy Beach, NSW 2097.

More on pendulum clocks

One of those few times when SILICON CHIP should be told instead of asked occurred in the October "Ask Silicon Chip" letter regarding electrical activation of a pendulum clock.

It is true that the IR method would probably use more power but what was missed is the necessity to use two detectors with gating, so as to energise the electromagnet only as the pendulum passes in one direction. Otherwise, the results would be unpredictable. In fact, the clock action would be chaotic. (I hope we are all informed about chaos?).

As for the alternative of driving the pendulum from a crystal clock IC, that too is doomed to failure because of chaos. Only a mathematical treatment (far too long for here) can properly analyse the system but consider some of its elements. Start the pendulum swinging and the clock pulse will occur somewhere at random along its cycle of travel. Chances are that the pulse is wasted by the pendulum being out of range of the electromagnet at that time.

If the clock and pendulum periods are closely matched (as would be expected for good timekeeping), it could take many swings before the pulse occurs while the pendulum is within range; so many that probably mechanical loses have damped the swing to the point where the magnet cannot build it up again.

After all, if you build a crystal clock into the project, why not get the time from it instead?

There is a way to get a self-synchronous electronic drive for the pendulum. First, the bob must incorporate a permanent magnet (mounted transverse to the arc) which swings past and above the pole faces of a central electromagnet. A small circuit involving one transistor is then used to sense the approach of the pendulum from the voltage transients induced in the electromagnet coil and to turn on a current pulse through the coil. Note that this happens twice per period; ie, at the bottom of each swing.

The current pulse must terminate before the magnet moves appreciably past the pole faces or it would remove some of the kinetic energy imparted to the pendulum by its onset. In fact, this is the usual way to stabilise the swing amplitude – something which should be done to aid good timekeeping and which was at the heart of the mechanical contact arrangement.

This sort of drive was used in some electric clocks for motor cars before ICs were available for crystal clocks. Such clocks used a balance wheel with a hairspring instead of a pendulum but the principle is unchanged. (E. W., Florey, ACT).

24V version of fluoro inverter

I am in the process of building the 16W version of the fluorescent light inverter as designed by Otto Priboj in the February 1991 of SILICON CHIP. I will be using it in my 12V solar powered house, however I have plans to upgrade my system to 24V. Can the inverter be easily modified to run on 24V? (K. A., Kangaroo Flat, Vic).

• Although we have not tried it, it should be possible to run the inverter from 24V by changing the primary winding from 6 turns to 12 turns. No other circuit changes should be necessary although a bigger heatsink may be needed.

In the November 1993 issue, we also published a more complex inverter for fluorescent lights. It is suitable for 18 or 36 watt tubes, is more efficient and produces the same brightness from the tubes as if they were operated from the 50Hz mains supply. The design presented in February 1991 did not deliver full brightness from the fluorescent tube. The later design can be easily adapted to 24V.

Sick Teac needs adjustment

I am writing about a problem I am having with an integrated amplifier (Teac BX-330). I have attempted to repair the system but unfortunately the problem goes beyond my 17-year old capabilities. The problem is as follows. Due to ignorance and carelessness, the left speaker terminal was subjected to a fairly small (but fatal to the amplifier) external voltage.

The system consequently shut down. Initial inspection of the unit revealed two 'retired' 4A fuses in the power supply's secondaries. Thinking optimistically, I replaced these with new fuses of the same rating, only to murder them with a lethal burst of current when the system was once again powered up.

Advancing from the simplicity of replacing fuses, I began the tiresome task of a resistance check on the majority of components in the amplifying circuit. The fuse-blowing problem was found in the heart of the power amplifier (left channel). Both main transistors (the heatsunk ones) were well and truly dead.

On removing these offending pieces, I hit the power switch. Naturally the left channel would be dead (I didn't even supply it with a signal), however the right channel presented me with the usual performance; ie, it still operated OK.

The only complaint from this test was heating of two 5W resistors located within the power supply. Being impatient, I simply replaced the transistors and hoped the resistors would return to their normal operating temperature. With the transistors in place, the amplifier once again burst into action for about three minutes, after

Near field studio monitors

Could you please explain to me what is meant by the term "near field studio monitors" when applied to speakers suitable for use in a recording studio. How do these speakers differ from good quality hifi speakers? Has SILICON CHIP ever described a kit for near field studio monitors or a speaker kit that would be suitable for this application and if not, could this be done?

From what I have read, these monitors may be suitable for use with a PC fitted with a sound card and amplifier, where high-quality, high-level sound is required. As these sorts of systems are becoming popular, it may be a good opportunity to produce or revisit a kit approach to this type of speaker system. I appreciate your comments and look forward to hearing from you. (R. C., Stockport, SA).

• In audio parlance, "near field" refers to the response of transducers at very close proximity, in the pressure region. Hence "near field" microphones are used by vocalists (where they almost swallow the microphone). We would assume that "near field studio monitors" are intended for use in the confined spaces of recording studios, at listening distances of less than one metre.

If this is so, such speakers are unlikely to be suitable for use in domestic living rooms. We have contacted a number of audio equipment distributors on this question but none of them have been able to give any information.

which the transistors again died, taking the fuses with them.

With a circuit diagram in front of me and limited access to an oscilloscope, I'm stuck – not willing to sacrifice another two transistors for three minutes of music. I have included a copy of the circuit diagram and indicated the offending components. If you have any suggestions, I'm listening. (J. D., Blackburn South, Vic).

• There are a number of possible reasons as to why your amplifier's output stage is not working as it should. The first approach should be to measure the voltages marked on the circuit with no load attached. It is quite possible that the degree of heating in the 5W (marked 2W on the circuit) resistors is normal. If the associated voltages (+15.4V and -15.7V) are correct, then it should be OK.

However, the most important thing to do when you have replaced the output transistors in a power amplifier is to set the quiescent current using, in this case, trimpot R130. The relevant voltages for this are shown at the emitters of Q109 and Q110 (ie, +0.618V and -0.589V). Therefore, you should connect a digital multimeter across the 220Ω resistor between the emitters of Q109 and Q110 and adjust trimpot R130 until the voltage is 1.207V. Leave the amplifier operating for at least half an hour after doing this adjustment and redo it if the reading has increased.

The equivalent quiescent current through the output transistors can be calculated by dividing the total voltage between the output transistors (+0.012V, -0.007V) by the total resistance (0.66 ohms). This gives a quiescent current setting of 28 milliamps.

Wireless microphones need muting

Over the years, the magazines have designed bucket loads of FM wireless microphones but they are not much good for singers because they usually don't have enough dynamic range.

They aren't very good for announcements on PA systems either because they must be on all the time, even when you aren't speaking. If you turn them off, you get random radio noise coming out the speakers (unless you are using an expensive tuner).

So why have we all built one of them? Probably because they are really "neat" gadgets. How many of us are still using them? Not very many, I suspect.

I've heard that FM stereo is transmitted with a signal frequency to signify that it is stereo (around 16kHz). My suggestion is to add this frequency to one of your FM microphone circuits and then get a tuner with a stereo LED and use the LED output to switch a relay which disconnects the speakers when the mic is off. This stops noise from coming out the speaker when the mic is off or there is no audio. The relay could also be used to switch on music when the mic is off.

Can you make a project out of it? It just seems like a logical improvement for the old FM mic! (C. P., Coromandel Valley, SA).

• It is true that quite a few such circuits have been published over the years and that some are much better than others. The design featured in the October issue of SILICON CHIP is quite good although it does not incorporate your idea of muting.

FM stereo signals are transmitted with a pilot signal of 19kHz at ±7.5kHz deviation of the FM carrier (ie, 10% modulation). We would be reluctant to use this pilot signal as a mute control as you suggest because it would automatically switch the tuner into stereo whenever it was present. This is not a good idea for wireless microphone applications since tuners always have an inferior performance in stereo mode compared to mono mode.

What you really need is a VOX circuit to switch off the microphone when it isn't being used but which leaves the transmitter section operating to keep the tuner "quieted". We shall see what we can do.

Note & errata

Solar-Powered Electric Fence, April 1993: C4 should be increased from 10µF to 470µF to improve the supply decoupling and prevent erratic operation of the inverter circuitry.

UHF Remote Switch, December 1989 and August 1990: in some cases, the MC145028 decoder (IC2) may not operate correctly since the specified oscillator components cause it to operate at 770Hz which is outside its recommended frequency range of 1kHz to 400kHz. The solution is to change the timing components so that the oscillators operate at about 2kHz.

For IC1 in the transmitter, replace the resistors at pins 11 & 13 with 220kΩ and 100kΩ resistors respectively and change the .01µF ceramic capacitor at pin 12 to a .0022µF polyester type. For IC2 in the receiver, change the resistors at pins 7 & 10 to 39kΩ and 180kΩ respectively. The capacitors at pins 7 & 10 are unchanged.

MARKET CENTRE

Cash in your surplus gear. Advertise it here in Silicon Chip.

CLASSIFIED ADVERTISING RATES

Advertising rates for this page: Classified ads: $10.00 for up to 12 words plus 50 cents for each additional word. Display ads (casual rate): $20 per column centimetre (Max. 10cm). Closing date: five weeks prior to month of sale.

To run your classified ad, print it clearly in the space below or on a separate sheet of paper, fill out the form & send it with your cheque or credit card details to: Silicon Chip Classifieds, PO Box 139, Collaroy, NSW 2097. Or fax the details to (02) 979 6503.

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

_____ _____ _____ _____ _____

Enclosed is my cheque/money order for $_____ or please debit my

❑ Bankcard ❑ Visa Card ❑ Master Card

Card No. | | | | | | | | | | | | | | | | |

Signature_____ Card expiry date_____/_____

Name _____

Street _____

Suburb/town _____ Postcode_____

ANTIQUE RADIO

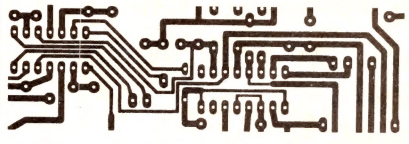
ANTIQUE RADIO RESTORATIONS: specialist restoration service provided for vintage radios, test equipment & sales. Service includes chassis rewiring, recondensering, valve testing & mechanical refurbishment. Rejuvenation of wooden, bakelite & metal cabinets. Plenty of parts – require details for mail order. About 1200 radios within 16,000 square feet. Two-year warranty on full restoration. Open on Saturday 10am-4.30pm; Sunday 12.30-4.30pm. 109 Cann St, Bass Hill, NSW 2197 Phone (02) 645 3173 BH or (02) 726 1613 AH.

FOR SALE

THE HOMEBUILT DYNAMO: (plans) brushless, 1000 DC watt at 740 revs. $A85 postpaid airmail from Al Forbes, PO Box 3919 - SC, Auckland, NZ. Phone Auckland (09) 818 8967 any time. Rotor magnets (3700 gauss) kit now available.

WEATHER FAX programs for IBM XT/ATs *** "RADFAX2" $35 is a high resolution, shortwave weather fax, Morse & RTTY receiving program. Suitable for CGA, EGA, VGA and Hercules cards (state which). Needs SSB HF radio & Radfax decoder. *** "SATFAX" $45 is a NOAA, Meteor & GMS weather satellite picture receiving program. Needs EGA or VGA plus "WEATHER FAX" PC card. *** "MAXISAT" $75 is similar to SATFAX but needs 2Mb expanded memory (EMS

RCS RADIO PTY LTD



RCS Radio Pty Ltd is the only company that manufactures and sells every PC board and front panel published in SILICON CHIP, ETI and EA.

RCS Radio Pty Ltd,
651 Forest Rd, Bexley 2207.
Phone (02) 587 3491

TRANSFORMER REWINDS
ALL TYPES OF TRANSFORMER REWINDS
TRANSFORMER REWINDS
Reply Paid No.2, PO Box 438, Singleton, NSW 2330. Ph: (065) 76 1291. Fax: (065) 76 1003.

ELECTRONIC CAD FOR DOS
Zeus 2000SCH: $150 Parts Database: $30
Zeus 2000PCB: $200 Micro PCB: $80
Payment by cheque/mo. Add $5 postage.
G. A. GEORGOPOULOS
34 Scouller St, Marrickville, NSW 2204.

3.6 or 4.0) and 1024 x 768 SVGA card. All programs are on 5.25-inch or 3.5-inch disks (state which) & include documentation. Add $3 postage. Only from M. Delahunty, 42 Villiers St, New Farm, Qld 4005. Phone (07) 358 2785.

PAT TV & SATELLITE Scrambling News Monthly, with the latest on descrambling techniques & addresses, where to buy the latest descramblers. Send stamp for info. John Papp, Box 37885 Winnellie, NT 0821.

PRINTED CIRCUIT BOARDS for the hobbyist. For service & enquiries contact: T. A. Mowles (08) 326 5590.

CONTROL RELAYS, Robots, Radios or Railways from LPT1: of your XT to 486 PC. 64 bits. Fully expandible. Demo programs, flow charts, circuits, drivers in M.L. & Basic. Main PCB & software $35. Don McKenzie, 29 Ellesmere Crescent, Tullamarine 3043. Phone (03) 338 6286.

MICROWAVE SYSTEM CATEL MWV-2000 23GHz including baseband equipment; 2-channel expandible, never used; original value approx. $22,000 only $8000. **SATELLITE DISH** 1.5m AWA with Ku band LNC $220. **PHASE-TRACK LINIPLEX** F1 PLL HF Rx 9 ch

MEMORY & DRIVES
PRICES AT DECEMBER 1ST, 1993

SIMM		
1Mb x 3	70ns	$70
1Mb x 9	70ns	$82
4Mb (72-pin)		$275
4Mb x 9	70ns	$250
4Mb x 8	80ns	$230
DRAM DIP		
1 x 1Mb	70ns	$8
256 x 4	70ns	$8
1Mb x 4	Z	$35
IBM PS.2		
50/55/70	2Mb	$160
70/35	4Mb	$275
90/95	4Mb	$275
MAC		
2Mb SI & LC		$130
4Mb P'Book		$330

CO-PROCESSORS		
387SX to 25		$105
387DX to 33		$105
LASER PRINTER HP		
with 4Mb		$260
TOSHIBA		
T3200SX	4Mb	$360
T44/6400	4Mb	$340
T5200	8Mb	$680
SUN		
SPARC 10/20	16Mb	$1100
DRIVES		
SEAG 42Mb	28ms	$190
SEAG 130Mb	16ms	$290
SEAG 452Mb	12ms	$750

Sales tax 21%. Overnight delivery. Credit cards welcome.
Ring for Latest Prices
1st Floor, 100 Yarrara Rd, PO Box 382, Pennant Hills, 2120.
Tel: (02) 980 6988
Fax: (02) 980 6991
PELHAM

ICL 286 Board
All in one board with two serial, printer, IBM keyboard, high density floppy & IDE mono video interface. Up to 4Mb RAM, 80286-16cpu, MS-DOS compatible, 130 page manual, small size 170mm x 255mm.
$299

Ampo little PC
All in one NEC V40 CPU board, MS-DOS compatible, high density floppy. SCSI hard disk, 2 serial, printer, solid state hard disk, IBM keyboard interface, (4W), CMOS single +5V rail, up to 768Kb RAM, 384Kb ROM, 145mm x 250mm, 98-page manual. **$299**

Kits
Max I/O kit for PCs, 7 relays, ADC, DAC, stepper driver, TTL inputs, with software **$169**
PC I/O card with 8255 chip 24 I/O lines programmable as inputs or outputs **$69**
1.5 watt AM broadcast transmitter XTAL locked **$49**
2.5 watt FM broadcast transmitter 88-108MHz. **$49**
Digi-125 audio power amp (over 19,000 sold since 1987) 50 watt/8 **$14** 125 watt/4 **$19**
New 200 watt/2 version **$29**
Infrared relay kit **$9**
Remote control tester **$4**

P.C. Computers
36 Regent St, Kensington, SA. Phone (08) 332 6513.

LSB-DSB-USB crystal locked $400. **SHURE M615** Equalisation Analyser (unused) $600. 3 off **NAKAMICHI 1000** stereo cassette decks (service manual included) $750. **NAKAMICHI HiCOMM II** Noise Reduction System (as new) $65, **dBX 11 122** Noise Reduction Unit $30, **dBX 119** Compresser Expander $30, **QUAD 405** Power Amplifier $150. Offers considered. Ron Beckett, 10 Gwandalan St, Emu Plains, NSW. AH (047) 35 6883; BH (02) 287 4918.

TEST EQUIPMENT – COMPANY CLOSING DOWN

Trio CS2070 4-Chan CRO with probes	$1000.00
Philips PM6456 FM MPX Signal Generator	$500.00
Philips PM5326 AM/FM RF Sig Gen & Sweep Oscillator	$1000.00
Philips AM/SSB 201 CB Transceiver inc. mic	$100.00
Leader LMV181A AC Millivoltmeter	$150.00
Heath IG18 Sine/Square Audio Generator	$100.00
Yaesu FT200 Transceiver, inc. Mic & Speaker	$300.00

All in good condition & in working order. Service manuals available for most items. Contact Norm Hughes on (018) 38 2288

Advertising Index

All Electronic Components 67
Altronics 26-28
Antique Radio Restorations 95
A-One Electronics 49
Cebus Australia 59
Contan Audio 87
David Reid Electronics 7
Dick Smith Electronics 12-15
D & K Wilson Electronics 51
Harbuch Electronics 7
Jaycar 33-35, 61-64
JV Tuners 55
Kalex 87
Kenwood Australia ..... IFC
PC Computers 96
Pelham 96
Peter C. Lacey Services 56
Philips Test & Measurement .... IBC
RCS Radio 95
Rod Irving Electronics 74-79
Silicon Chip Back Issues 68-69
Silicon Chip Binders 73
Silicon Chip Book Club 3
Technical Applications 91
Tektronix ..... OBC
Transformer Rewinds 96

PC Boards

Printed circuit boards for SILICON CHIP projects are made by:

- RCS Radio Pty Ltd, 651 Forest Rd, Bexley, NSW 2207. Phone (02) 587 3491.
- Marday Services, PO Box 19-189, Avondale, Auckland, NZ. Phone (09) 828 5730.
- H. T. Electronics, 35 Valley View Crescent, Hackham West, SA 5163. Phone (08) 326 5590.

FLUKE AND PHILIPS - THE GLOBAL ALLIANCE IN TEST & MEASUREMENT

FLUKE®

PHILIPS

PHILIPS

70 SERIES II

We've improved on a winner

If you've waited for the next generation digital multimeter technology, you've made the right choice. Now there is the new Fluke 70 Series II. We've made the world's most popular DMM's even better.

At the top of the line, the new Fluke 79 and 29 blend high-performance features – capacitance, frequency, a fast 63-segment bar graph, Lo-Ohms range, Smoothing™, faster ranges – and affordability.

At the entry level, the new model 70, Fluke's lowest-priced DMM ever, delivers unparalleled Fluke quality and safety.

"Basics" Redefined

No matter which 70 Series II you choose, you get simple, one-handed operation. High resolution. And built-in reliability.

Automatic Touch Hold® – standard on every model – locks the reading on the display and signals you with a beep. Leaving you free to concentrate on your work, not on your meter.

There's also fast autoranging. A quick continuity beeper. Diode test. Automatic self-test. Overload protection, even in the 10 amp range. And a sleep mode that automatically powers down the meter when you forget to.

Best of all, every 70 Series II is a Fluke, backed by a worldwide service network and 3-year warranty.

1

Be No. 1 with Fluke and Philips

Available from the following Philips Test & Measurement distributors:

ALL STATES: BEP, Dick Smith Electronics, GEC, Petro-Ject.

NSW: Ames Agency, Auslec, CLC Agencies, Consultant Technologies, David Reid Wholesalers, DGE Systems, Ebson, Elect. Smith Projects, Emcorp, Illawara Ind. Instrumentation, J.Blackwoods & Son, Lawrence & Hanson, Macelec, Novocastrian, Obiat, Stott Ind. Suppl., Tech Fast, Tecnico, Vincom.

ACT: Advanced Instrument Services, Aeromotive Maintenance, John Pope Electrical.

VIC: Auslec, Emcorp, Factory Controls, J. Blackwoods, Parallel Systems, Radio Parts Group.

QLD: Auslec, Colourview Electronics, Emcorp, Industrial & Marine Electrics, J.Blackwoods, L.E. Boughen, Mass Electronics, Nortek, Solex, St. Lucia Electronics, Thomson Instruments.

S.A: A.W.M. **TAS:** George Harvey.

W.A: Atkins & Carlyle, Leda Electronics, R.S. Components.

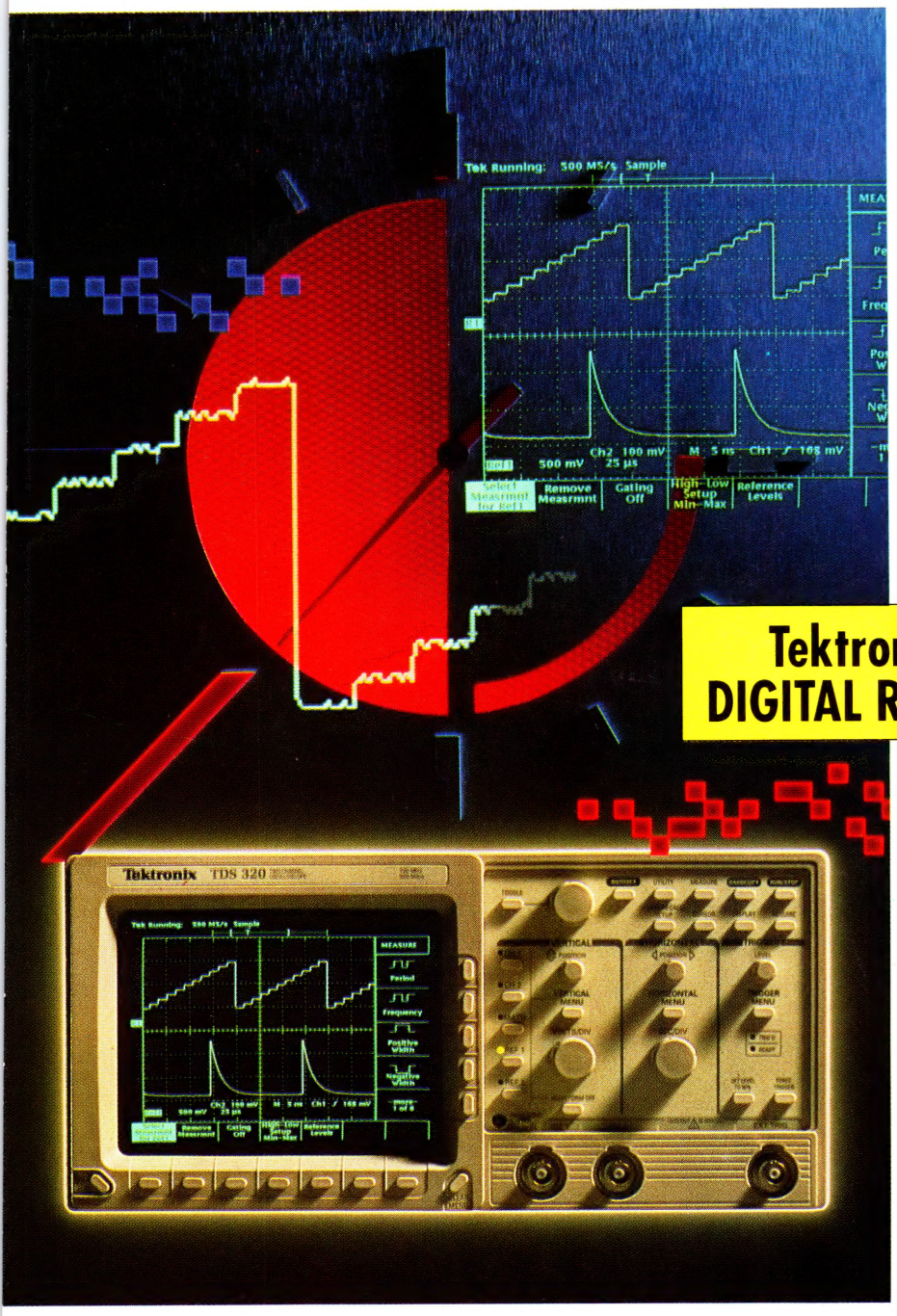
N.T: Industrial Suppliers & Switchgear J.Blackwoods.

PHILIPS

PHILIPS

Digital Real Time is here!

RENTAL/PURCHASE AND GOVERNMENT USAGE PLAN AVAILABLE



The TDS 320 redefines the LOW COST DIGITAL STORAGE OSCILLOSCOPE with features such as:

- *500 MS/Sec DIGITISING SPEED ON EACH CHANNEL*
- *100 MHz SINGLE SHOT STORAGE*
- *21 AUTOMATIC MEASUREMENTS*
- *REAL TIME VECTOR DISPLAY*
- *10ns PEAK SIGNAL DETECTION*
- *UNIQUE GRAPHICAL USER INTERFACE*

Tektronix TDS 320, 100MHz DIGITAL REAL TIME OSCILLOSCOPE

The TDS 320 also offers the usual DSO benefits such as optional waveform hard copy and communications interfaces. The 3 year warranty continues the high standard set by other TDS scopes. At a price of ***$4395****, you can afford to own one and see what you have been missing.*

**Price does not include sales tax*

Call now for details and specifications

FREE CALL (008) 023 342

Tektronix